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CONCRETE PIERS built in open pits will form the foundations for the new building now being constructed for the Chicago "Tribune." The pits are 4½ to 8 ft. diameter, and about 100 ft. deep, extending down through the stiff Chicago clay into the hardpan. The bottom section of the shaft is enlarged to form a conical chamber, the diameter of the base being double that of the shaft proper. As each stage of 5 ft. in depth is completed, the shaft is lined with wooden staves, held in place by inside iron rings or belts. The excavation is done by hand, and the material is hauled up by the slow and tedious process of rough hand hoists, the hoisting rope being carried over a sheave and down to the small wooden drum to which the crank handles are attached. Two and sometimes three men are required to hoist a bucket in this way. When the pits are completed they are filled with a concrete composed of 1 part Portland cement, 3 parts sand and 5 parts broken stone. The concrete is mixed by hand and is very dry. Around the site is driven Wakefield triple-lap sheet piling, inside of which is round piling, driven by a steam pile-hammer and capped with a bed of concrete. The contractors for the foundation work are A. W. Smith & Sons, of Chicago. The building will be of the steel skeleton frame type, and the Geo. A. Fuller Co., of New York and Chicago, has the contract for the steel work.

GRADE CROSSINGS IN CHICAGO are by no means entirely eliminated yet, in spite of the extensive track elevation work already accomplished. So numerous have the grade-crossing accidents become this season that the Mayor has ordered the railway companies to station watchmen at about 50 of the most dangerous crossings. In the four months of July to October (inclusive) last year there were 28 persons killed and 63 injured at the grade crossings, and it is hoped that no such record will be made this year if watchmen are provided. One short piece of line has been closed to traffic by the C., M. & St. P. Ry., as the city has refused to allow electric traction to be introduced (to enable it be operated as an extension of the elevated railway system), and the steam traffic had caused a number of accidents at the crossings.

THE "NORTHWESTERN," the first of the four direct Chicago-London steamers, arrived at Liverpool on June 10, having left Chicago on May 25. It was expected that she would make the trip in 21 days; but damage to a propeller-blade from ice in Lake Huron, compelled docking and delay for 8 days. Collision with a dredge in the St. Lawrence caused another delay of 10 days. In the passage across the Atlantic the "Northwestern" averaged 10 knots.

THE SHIPPING RECORD for the Sault Ste. Marie Canal was broken in June of this year, by a tonnage of 4,509,075 tons of freight passing through. This exceeded the next largest month's traffic—June, 1900, by 400,000 tons. The largest items were—3,161,982 tons iron ore, 3,421,802 bushels wheat, and other grain 1,667,757 bushels. In all, 3,197 vessel passages were recorded, with a registered tonnage of 3,975,392.

A FOG SIGNAL which is self-locating was recently tested at Falkner Island by the United States Light-House Board. It consists of a siren driven by a gas engine, and provided with eight megaphones pointing to the points of the compass. Specific signals are automatically given through each megaphone; for instance, if there is one long blast the signal is North of the observer, one long and one short blast indicate that the signal is directly East, etc. It has been found that when a vessel is within half a mile of the apparatus, the signal pointing towards it can be heard with great loudness, while the others are scarcely audible. At distances of from two to ten miles it is impossible to hear any signals except those from the megaphone pointed directly at the observer. A modification of the apparatus has been perfected for use on board ship. The machines are manufactured by the Hamilton-Foster Co., Bowling Green Bldg., New York city.

THE SUEZ CANAL in May, 1901, yielded a transit revenue of $1,824,000, as compared with $1,582,000 in May, 1900. In last May 343 ships passed through the canal. For the first five months of this year the transit revenue aggregated $7,340,490, from a total of 1,588 vessels.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Lake Shore R. R. at Nottingham, O., on July 9. The Southwestern limited express from St. Louis was derailed, resulting in the deaths of two persons and the serious injury of two others, one of whom will probably die.——Two persons were killed and two seriously injured by the derailment of a locomotive tender and two coaches of a passenger train on the Iowa Central Ry. at Hampton, Ia , on July 5.

THE NEW CAISSON for dry dock No. 2 at the Brooklyn Navy Yard, New York, was accidentally sunk on July 7, while preparations were being made to place it in position at the entrance of the reconstructed dock. The caisson is 72 ft. long on the bottom, 94 ft. long on top, 22 ft. wide, and weighs 250 tons. The work of raising the caisson will be begun at once.

THE FIRE LOSS OF THE UNITED STATES and Canada for the first six months of 1901 amounts to $88,935,150, as compared with $103,298,900 for the same period in 1900, and $65,699,750 for the first six months of 1899.

A NEW GATE FOR A SHAFT-CAGE, in mining operations, is described in the "Annales de Belgique." It is applied in the coal mines of Oignies-Oiseau, and is attached to the vertical front of the cage, this cage having a roof as wide as the car platform. The gate is made of flat bars, pivoted at the middle and the ends after the manner of a "lazy-tongs;" and when shut it closes the whole space between the roof and the floor. When shut, it presents two full lozenges in the center and two half lozenges at top and bottom; the upper bars slide in a slot in the roof, and the lower bars are attached to a horizontal bar sliding in guides at the side of the cage. Another horizontal bar, crossing the bottom full lozenge, likewise runs in these side slots. This gate is lifted and secured by a chain; and is then entirely concealed in the roof, leaving the whole side of the car open. For a height of 4 ft. 3 ins., this gate weighs only 13.2 lbs.

IRON ORE IN THE GULF OF FINLAND, near the Island of Jussaro, is to be mined by a syndicate headed by Baron Nordenskiold. Many shipwrecks have taken place at this point, owing to the untrustworthiness of the compass, and the presence of iron under the water was known as early as 1750. Borings made show that the roof rock is compact and water-tight, and that the deposits represent at least 50,000,000 tons of ore. The average yield of iron is 36% from about 1,000 tons of ore already raised.

COAL UNDER SYDNEY HARBOR, N. S. W., had been found by borings made in 1893. At a depth of 2,917 ft. the top of a 10-ft. 3-in. coal seam was found. This coal is good for household use, is good steam coal and yields an excellent coke. The Sydney Harbor Collieries Co. now has authority to mine this coal over an area of 10,167 acres, and an attempt is to be made to sink a shaft.

SMELTING ORES BY ELECTRICITY is the subject of experiments being made at Brescia, Italy, where a 500-HP. furnace has been installed. The process is the invention of Captain Stassano, of Rome, and the experiments are being conducted before a commission composed of Messrs. Arno, of the Milo Polytechnic, Del Lemgo, of the Institute of Spegia, and Engineer Seracusa, Director-General of the Italian Electric Co., of Turin.

AN OIL TANK, holding 1,260,000 gallons, has been built by the Market Street Ry. Co., of San Francisco, Cal. It is of steel, 90 ft. in diameter and 30 ft. high, and is to be used to store fuel oil for use in the electric power-houses of the Market St. Ry. Co., which is substituting oil for coal. The oil is said to cost 30 cts. per barrel at the wells in Kern Co., Cal., and the transportation charges to San Francisco are 42 cts. The oil will be distributed to the power houses by means of tank wagons.

AN AUTOMOBILE ROAD contest from New York city to Buffalo has been arranged for by the Automobile Club of America. The test will occupy six days, and the start will be made at the club-house of the Automobile Club, at 58th St. and Fifth Ave., in New York city, on the morning of Sept. 9. The vehicles must all follow the roads selected by the club and cover certain stages in each day, each of 88 to 90 miles in length. The total distance to Buffalo is 500 miles. The object of the test is to determine the general qualities of reliability and endurance of the vehicles, and the route will include all conditions of roads likely to be met with in a general tour of the State. Entries must be made before Aug. 31, and a reduced entry fee will be accepted if the entry is made before Aug. 15. Full preparations are being made for the test, and a complete set of regulations has been prepared. The chairman of the committee having the matter in charge is Mr. W. M. Power.

A CIVIL SERVICE EXAMINATION for structural steel-work draftsman, at a salary of $1,500 per year, to occupy a position in the Department of Yards and Docks, will be held at the Navy Yard at Norfolk, Va., on July 16. Applications should be addressed to the Commandant. The examination will be open to all comers who can give evidence of experience in the kind of work for which they seek employment, and who are citizens of the United States. Persons now holding positions at the yard will be admitted to competition on the same footing as other applicants. The applications will be accompanied by evidence of citizenship, and by certificates, preferably from previous employers, as to character, habits of industry and sobriety, and skill and experience in work of the kind required. The examination will be practical in character, having reference exclusively to the requirements of the position to be filled. The applicant's antecedents and experience, as well as the character of his previous work, will be duly considered by the board in making its recommendations. The board will make sufficient inquiry to ascertain that the applicants recommended are fit for the work; that they have enough education to make the required reports, estimates and calculations; that they are of reputable character, and of sober and industrious habits, and that they have not been convicted of crime or misdemeanor.

ELECTRIC TRACTION ON THE LONDON UNDERground railways is delayed by the fact that the railway companies interested are unable to decide between the Ganz system and the system designed by American engineers proposed by Mr. Yerkes. The Parliamentary Committee approves of the American system, but it has ordered the Board of Trade to appoint a committee of experts to determine which system shall be selected. Mr. Yerkes is ready to push the work as soon as this preliminary is settled.

THE LOSCHWITZ SUSPENSION RAILWAY, in Saxony, was opened to traffic on May 6. Loschwitz is about 5 miles from Dresden, and the line extends from this village to the top of the Rochwitz Mountain, commanding a view of Dresden and the country about it. The railway is only 820 ft. long, but has a gradient of 32%. It is built on the Langen system, with 33 iron piers carrying the track from which the cars are hung. Each car carries 50 passengers and filled weighs 12.8 tons. The system is double track, with the rails on the outside supported from the piers by cantilevers. The steel hauling cable is 1.7 in. diameter, and is operated by two 80-HP. engines both at the top of the incline. Each car is provided with three brakes—two of which work automatically at the least slackening of the hauling rope, and one is worked by hand from the car. Automatic brakes at the top and bottom stop the car.

THE NEW METROPOLITAN RAILWAY OF PARIS now carries a daily average of 115,000 passengers.

THE NEW GLASGOW AQUEDUCT, taking water from Loch Katrine, was opened on June 22. It is 34½ miles long and cost $6,602,000, with its mains, as compared with $7,577,800 for the old Glasgow-Loch Katrine aqueduct. The combined aqueducts supply Glasgow with 110,000,000 gallons per day, and the reservoirs hold 24 days' supply, on a basis of 50,000,000 gallons per day consumed.

THE PHILADELPHIA CITY HALL, commenced in 1871, has cost $24,313,455, according to a late report of the Public Buildings Commission—which is now to be superseded by the city administration. The largest single item of expenditure was $5,467,503 for marble, not including a bill of $2,017,299 for dressed stone for inside finish. For fitting up rooms for city departments the Commission spent $3,990,211; for cast and wrought iron, $1,122,543; metal work on tower, $756,537; architects fees and salaries, $317,452; lawyers' fees, $28,643. Heating and ventilating cost $682,607; electric light installation, etc., $736,767; tower clock, $27,960; painting and glazing, $351,490, and "labor and watching" cost $1,342,396, and "superintendents and assistants" drew $317,452 more.

ship from the specifications and general plans, and to be able to make designs of details from rough sketches.

Leading ship draftsmen, 1st class.....$6.00 per diem.
" " " 2d " ..... 5.52 " "
Ship draftsmen in charge..... 7.04 " "

QUALIFICATIONS.—In addition to items for assistant ship draftsmen and ship draftsmen, to have good knowledge of calculations for strength of materials. To thoroughly understand the calculation of stability, equivalent girders and launching calculations. To have clear ideas of administration of a drawing office, distribution of work and keeping of records. To be able to design important features of a ship, such as drainage, ventilation, etc., from specifications and general instructions.

METHOD OF FILLING VACANCIES.—Where vacancies occur which cannot be filled advantageously by transfer or promotion, a local board of examiners shall be appointed by the Secretary of the Navy. The methods of procedure and report of the board shall be similar to those now prescribed for examinations for positions as assistant inspector, inspectors of steel, special mechanics, etc. The board shall base its examination upon the qualifications laid down for the grade for which the examination is held, and in determining the rank of candidates the following scheme of marks shall be adhered to:

Record and testimonials:	
Sobriety and character	100
Skill as a draftsman	100
Experience and training	200
Oral examinations:	
Age and physique	100
Professional qualifications	200
Written examination:	
Education	100
Professional qualifications	200
Total	1,000

MARINE ENGINE AND BOILER DRAFTSMEN.

Copyist marine engine and boiler draftsmen, 1st class.....$3.28 per diem.
Copyist marine engine and boiler draftsmen, 2d class..... 3.04 " "
Copyist marine engine and boiler draftsmen, 3d class..... 2.80 " "

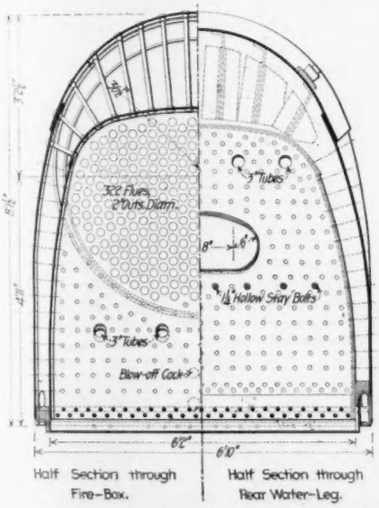


Fig. 3. Transverse Sections of Locomotive Boiler.

WRITTEN EXAMINATION.—(a) The answers to the questions of the supplementary statement (Navy Yard Orders, Form 30) will be marked for composition, penmanship, spelling and punctuation, and will be given equal weight with each of the following lettered questions:

(b) Solution of one problem in square root, and one in cube root; another to test the applicant's knowledge of the solution of problems by logarithms; solution of plane triangles to determine knowledge of trigonometric functions—a table of natural functions, or a logarithmic table to be furnished the applicant.

(c) Problems in mensuration of plane surfaces, and in volumes of regular figures, and in connection with the latter, the weight of material. The problems will be so prepared as to test the applicant's knowledge of vulgar and decimal fractions. The use of different materials in engine and boiler construction.

(d) Outline sketch of a marine boiler, giving the names of the different parts, and indicating where joints occur. Show how different materials are indicated by hatching.

Drawing.—A practical exercise in making a finished drawing in ink of a portion of an engine, with lettering, giving name of part, date and name of draftsman.
Schedule of marks:

Drawing	500
Written examination	250
Experience	200
Testimonials	50
Total	1,000

Asst. marine engine and boiler draftsmen, 1st class.....$4.00 per diem.
Asst. marine engine and boiler draftsmen, 2d class..... 3.76 " "
Asst. marine engine and boiler draftsmen, 3d class..... 3.52 " "

WRITTEN EXAMINATION.—(a) The answers to the questions of the supplementary statement (Navy Yard Orders, Form 30) will be marked for composition, penmanship, spelling and punctuation, and will be given a weight of 50.

(b) Solution of one problem in square root and one in cube root; another to test the applicant's knowledge of the solution of problems by logarithms; solution of plane triangles to determine knowledge of trigonometric functions—a table of natural functions, or a logarithmic table to be furnished applicant; mensuration of irregular surfaces and volumes.

(c) Intersection of surfaces of revolution and development of the curve of intersection; center of gravity.

(d) Indicator diagrams; explain and show how to calculate indicated horse-power therefrom. Draw and explain from given data a Zeuner or other valve diagram. Find pitch of screw propeller from given data.

(e) Calculate the thickness of the shell of a cylindrical boiler for a given diameter and pressure, strength of joint, and tensile strength of the material, and give diameter and spacing of rivets for the longitudinal joint. Books of reference will be furnished for this question.

Drawing.—A practical exercise in making a finished drawing in ink of a portion of an engine, with lettering, giving name of part, date and name of draftsman.
Schedule of marks:

Drawing	400
Written examination	350
Experience	200
Testimonials	50
Total	1,000

Marine engine and boiler draftsmen, 1st class.....$5.04 per diem.
Marine engine and boiler draftsmen, 2d class..... 4.72 " "
Marine engine and boiler draftsmen, 3d class..... 4.48 " "

WRITTEN EXAMINATION.—(a) The answers to the questions of the supplementary statement (Navy Yard Orders, Form 30) will be marked for composition, penmanship, spelling and punctuation, and will be given a weight of 50.

(b) Find the diameter for cylinders of an engine of given i. h. p., steam pressure, revolutions and stroke; diameter of piston valve for the h. p. cylinder and width of the ports.

(c) Find the size of some part of the above engine, such as the piston rod, connecting rod or the crank shaft.

(d) Find the length of bearings for an engine from given data. Draw a valve diagram for the engine in question (b). Explain indicator diagrams and show how to calculate indicated horse-power from them. Explain the construction and operation of link and of radial valve gears.

(e) From given data find the thickness of the different plates, stays, etc., of a marine boiler.

Books of reference will be furnished for questions (b), (c) and (e).

Drawing.—A practical exercise in making a finished drawing in ink of a portion of an engine, with lettering, giving name of part, date and name of draftsman.
Schedule of marks:

Drawing	350
Written examination	400
Experience	200
Testimonials	50
Total	1,000

ELECTRICAL DRAFTSMEN.

Copyist electrical draftsmen, 1st class....$3.28 per diem.
" " " 2d " .... 3.04 " "
" " " 3d " .... 2.80 " "

(a) The questions in mathematics will comprise questions in involution, evolution, proportion, mensuration of plane surfaces, volumes of solids, solution of plane triangles.

(b) The questions in materials used in electrical devices will be on the kind of materials used in the manufacture of dynamos and motors.

(c) The questions in electricity will comprise the theory, description and uses of the different kinds of dynamos; description and sketches of switchboards, with the various instruments thereon.

(d) The questions in drafting will be in making a finished drawing in ink from a sketch of some part of a dynamo, engine, fixtures, or electrical device; also a tracing from a finished drawing.

(e) The marking on education and experience will be based on facts submitted with supplementary statement and certificates of graduation from technical schools and testimonials and statements from former employers.

(f) The composition, spelling, etc., of the written examination; also the application and supplementary statement (Navy Yard Orders, Form 30) will be considered under the heading "Education and experience."
Schedule of marks:

Mathematics	10
Materials used in electrical devices	5
Electricity	15
Drafting	50
Technical education and experience	20
Total	100

Asst. electrical draftsmen, 1st class.....$4.00 per diem.
" " " 2d " ..... 3.76 " "
" " " 3d " ..... 3.52 " "

(a) The questions in mathematics will comprise questions in involution, evolution, proportion, mensuration, volumes of solids, solution of plane triangles, intersections of surfaces and development of the curve of intersection.

(b) The questions in materials used in electrical devices will be on the kind of materials used in the manufacture of dynamos, engines, motors, wiring appliances, wire and its insulation.

(c) The questions in electricity will comprise the theory, descriptions and uses of the different kinds of dynamos and motors; description and sketches of switchboards, with the various instruments thereon; working problems under Ohm's law; description of primary and secondary batteries; arrangement of batteries for given requirements; testing instruments; laying out a scheme for wiring a naval vessel for light, power and interior communication.

(d) The questions in drafting will be in making a finished drawing in ink from a sketch of some part or parts of a dynamo, engine, fixture or electrical device; also making a tracing from a finished drawing.

(e) The marking on education and experience will be based on facts submitted with supplementary statement and certificates of graduation from technical schools and testimonials and statements from former employers. The composition, spelling, etc., of the written examination, also the application and supplementary statement, will be considered under this heading.
Schedule of marks:

Mathematics	10
Materials used in electrical devices	5
Electricity	20
Drafting	35
Technical education and experience	30
Total	100

Electrical draftsmen, 1st class.....$5.04 per diem.
" " 2d " ..... 4.72 " "
" " 3d " ..... 4.48 " "

(a) The questions in mathematics will comprise questions in involution, evolution, proportion, mensuration, volumes of solids, solution of plane triangles, intersection of surfaces and development of the curve of intersection, curve tracing, strength of materials.

(b) The questions in materials used in electrical devices will be on the kind of materials used in the manufacture of dynamos, engines, motors, wiring appliances, wire and its insulation.

(c) The questions in electricity will comprise the theory, description and use of the different kinds of dynamos, motors and transformers; methods of motor control; description and sketches of switchboards, with the various instruments thereon; working problems under Ohm's law; description of primary and secondary batteries; arrangement of batteries for given requirements; telephones; testing instruments; laying out a scheme for wiring a naval vessel for light, power and interior communications.

(d) The questions in drafting will be in making a finished drawing in ink from a sketch of some part or parts of a dynamo, engine, fixture, or electrical device; also making a tracing from a finished drawing.

(e) The marking on education and experience will be based on facts submitted with supplementary statement and certificates of graduation from technical schools and testimonials and statements from former employers. The composition, spelling, etc., of the written examination, also the application and supplementary statement, will be considered under this heading.
Schedule of marks:

Mathematics	10
Materials used in electrical devices	5
Electricity	20
Drafting	35
Technical education and experience	30
Total	100

ARCHITECTURAL DRAFTSMEN.

Copyist architectural draftsmen, 1st class.$3.28 per diem.
" " " 2d " . 3.04 " "
" " " 3d " . 2.80 " "

WRITTEN EXAMINATION.—(a) The written examination and all written forms filled out by candidates will be marked for composition, penmanship, spelling and punctuation.

(b) Problems in arithmetic up to and including cube root and including vulgar and decimal fractions, least common multiple and greatest common devisor.

(c) Problems in elementary geometrical construction.

(d) The character of different building materials and the proper use of materials in architectural construction.

(e) The method of indicating different materials on drawings.

(f) Free-hand sketches of the elements of architectural designs.

Drawing.—Tracing in ink from blue print or from pencil drawings, lettering, tracing and designing a title for drawing. To be marked for rapidity, as well as for neatness and accuracy. Exercise in free-hand sketches and free-hand lettering.
Schedule of marks:

Testimonials	10
Education and experience	10
Written examination	20
Drawing and tracing	60
Total	100

Asst. architectural draftsmen, 1st class...$4.00 per diem.
" " " 2d " ... 3.76 " "
" " " 3d " ... 3.52 " "

(a) Mathematics.—Problems in arithmetic that will test the candidate's accuracy, and embracing, among other heads, two or more of the following: Addition, multiplication, fractions, least common multiple, greatest common divisor, square root, cube root. Problems in geometrical construction.

(b) Knowledge of Materials of Construction.—The characteristics of and requirements for first-class building materials. Pen and ink sketches of details of construction. Knowledge of particular features of construction in buildings of different kinds.

(c) Drawing.—Making drawings, including elevation and a floor plan of a building suitable for navy yard use. General specifications as regards dimensions and materials to be furnished the candidates. Making a tracing in ink of a pencil drawing; enlarging an ornamental detail. Free-hand lettering.
Schedule of marks:

Testimonials	10
Education and experience	20
Mathematics	10
Knowledge of materials of construction	20
Drawing	40
Total	100

Architectural draftsmen, 1st class.....$5.04 per diem.
" " 2d " ..... 4.72 " "
" " 3d " ..... 4.48 " "

(a) Mathematics.—Problems in arithmetic up to and including cube root, designed to test the candidate's accuracy and rapidity. Problems in geometrical construction and problems involving a knowledge of algebra.

(b) Knowledge of Building Materials, Construction and Specifications.—Requirements for various materials, including tests that should be fulfilled; qualities of different building materials; choice of materials for different work; sketches for various architectural constructions and description of same; specifications for different classes of work.

"CHAUTAUQUA" TYPE PASSENGER LOCOMOTIVE; CHICAGO, ROCK ISLAND, & PACIFIC RY.

We present herewith a general view and some details of one of the "Chautauqua" type passenger locomotives recently built for the Chicago, Rock Island & Pacific Ry., by the Brooks Locomotive Works, of Dunkirk, N. Y.

As seen in the photograph, a trailing truck is placed in the rear of the drivers beneath the firebox, and the limitation to the width of the firebox which exists where it is placed between the driving wheels is obviated. This style of cons ruction has grown so rapidly in popularity since its first introduction about ten years ago, that it promises to become the standard for all soft coal burning locomotives, in any service where enough weight can be spared from the drivers to permit the use of the trailing truck.

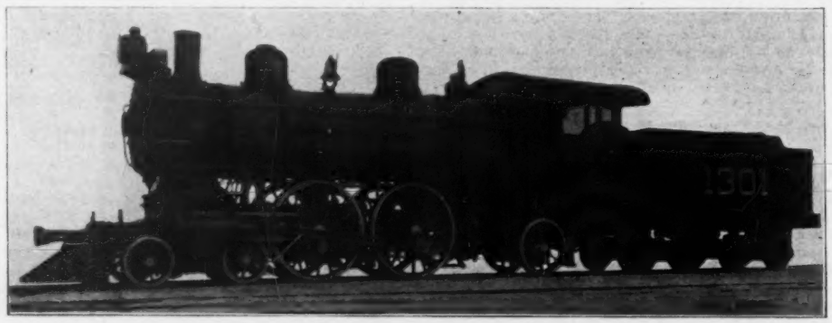


FIG. 1. "CHAUTAUQUA" TYPE PASSENGER LOCOMOTIVE; CHICAGO, ROCK ISLAND & PACIFIC RY.

G. F. Wilson, Superintendent of Motive Power; the Brooks Locomotive Works, Dunkirk, N. Y., Builders.

Referring to the drawings of the boiler, given herewith, it will be seen that the fire-brick arch is supported upon water tubes which are bent upwards in the middle to give greater stiffness, and also to give the back edge of the arch greater height, thus rendering easier the firing of the front part of the grate. The slope of the rear water leg is, also, an aid to easy firing, since it diminishes the distance to which the coal must be thrown. The rear sheet over the fire-door is supported by steel plate gussets, instead of the usual stays. At the throat of the boiler, that portion of the tube sheet between the stay-bolts and the tubes is supported by a stay fastened to the shell. The driving wheels carry about three-fifths of the total weight; the remainder is distributed equally between the forward truck and the trailing wheels. All wheels are provided with brakes. Piston valves are used, and the piston rods of the steam cylinder have metallic packings. The leading dimensions of the locomotive are given below in our standard form:

General Dimensions of "Chautauqua" Type of Passenger Locomotive; Chicago, Rock Island & Pacific Ry.

RUNNING GEAR:	
Driving wheels, No.....4; diameter	.....6 ft. 6½ ins.
Truck wheels, No.....4; diameter	.....3 ft.
Tender wheels, No. .....8; diameter	.....3 "
Driving wheel centers	Cast steel.
Engine truck, swing or rigid center	Swing.
Journals, driving axles	9 x 12 ins.
WHEELBASE: Driving	7 ft.
Total engine	28 ft. 8 ins.
Engine and tender	53 " 7 "
WEIGHT IN WORKING ORDER:	
On driving wheels	93,500 lbs.
On truck wheels	37,000 "
On trailing wheels	37,000 "
Engine, total	167,500 "
Tender, loaded	108,000 "
Water in tank	44,000 "
Coal on tender	16,000 "
CYLINDERS: Number	Two.
Diameter and stroke of high-pressure	20½ x 26 ins.
Connecting rod, length between centers	10 ft. 7 "
VALVE GEAR: Type	Stephenson.
Ports: Steam	25½ x 1⅞ ins.
Exhaust	75 sq. ins.
Bridges width	3½ ins.
Slide valves, style	Improved piston.
Maximum travel	5¼ ins.
Inside lap	1¼ "
Lead (full forward gear)	1-16-in.
BOILER: Type	Wagon top
Diameter barrel, inside smallest ring	5 ft. 6 ins.
Thickness, barrel plates	⅝, 11-16, 9-16, ½ ins.
Smokebox tube-plate	¾-in.
Horizontal seams (single or double riveted)	Double.
Circumferential seams (same)	Double.
Lap or butt joints	Butt with internal and external strips
Height from rail to center line	9 ft. 7¼ ins.
Length, smokebox, with extension	5 ft. 4½ "
Injectors	Nathan.
Working steam pressure	210 lbs.
FIREBOX: Type	Wide.
Length, inside	9 ft.; width, inside....6 ft. 2 ins.
Depth: At front..6 ft. 2 ins.; at back	5 " 4 "
Thickness, side plates	5-16-in.
Back plates	⅜-in.
Crown plate	⅜-in.; tube plate ⅝-in.
Kind of crown stays	Radial.
Kind of grate bars	Cast-iron rocking.
Is fire-brick arch used?	Fire-brick on water tubes.
Stay bolts	Hollow.
Water spaces, width at back	....7 ins.; at sides....6 ins.
TUBES: Material ..Charcoal iron; No.	322
Thickness	No. 11, B. W. G.
Diameter, outside	2 ins.
Length over tube plates	15 ft. 7¾ "
MISCELLANEOUS:	
Exhaust nozzle, single or double	Single.
Diameter	5½ ins.
Exhaust nozzle, dist. above (+) or below (—) center line of boiler	+ 1½ "
Smokestack, diameter at top	19½ "
Diameter at base	16 "
Height above smokebox	3 ft.
Height of top above rail	15 ft. 6 ins.
Capacity of tender tank	6,500 gallons.
Capacity of coal space	16,000 lbs.
Brake fittings	Westinghouse-American.

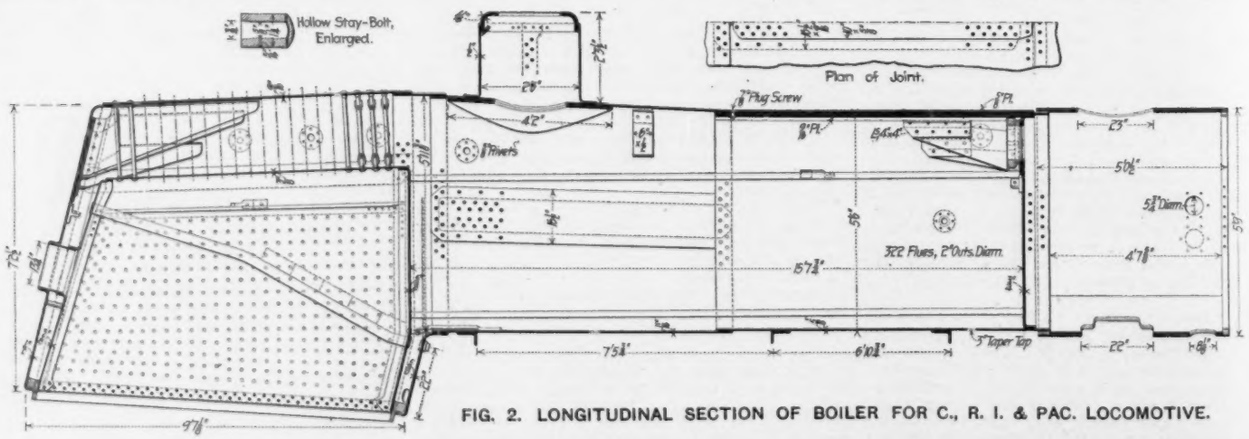


FIG. 2. LONGITUDINAL SECTION OF BOILER FOR C., R. I. & PAC. LOCOMOTIVE.

RULES GOVERNING THE EMPLOYMENT OF DRAFTSMEN BY THE U. S. NAVY DEPARTMENT

An official order (No. 225), has just been issued by the Navy Department, which is to govern the employment of draftsmen at all naval yards and naval stations in future. As frequent inquiries are made concerning the opportunities for employment in this field, we reprint the Department circular nearly in full below. All appointments are made only after competitive examination before a board of naval officers, and as seen below, the scope of the examination for each grade is clearly defined, and the daily pay for each grade is stated. Draftsmen in the naval service are classified, first, according to the bureau under which they are to work, as ship draftsmen, marine engine and boiler draftsmen, electrical draftsmen, architectural draftsmen, and structural steel-work draftsmen.

We quote from the circular the compensation given and qualifications required of the various grades in each of these divisions as follows:

SHIP DRAFTSMEN.

Assistant ship draftsmen, 3d class.....$2.40 per diem.
" " " 4th " ..... 2.00 " "

QUALIFICATIONS.—To have a good common school education. To be able to write legibly. To be accurate in arithmetic to and including proportion, common fractions, decimals and percentage. To have an elementary knowledge of mechanical drawing. Other things being equal, preference will be given to candidates who have knowledge of ships and ship work.

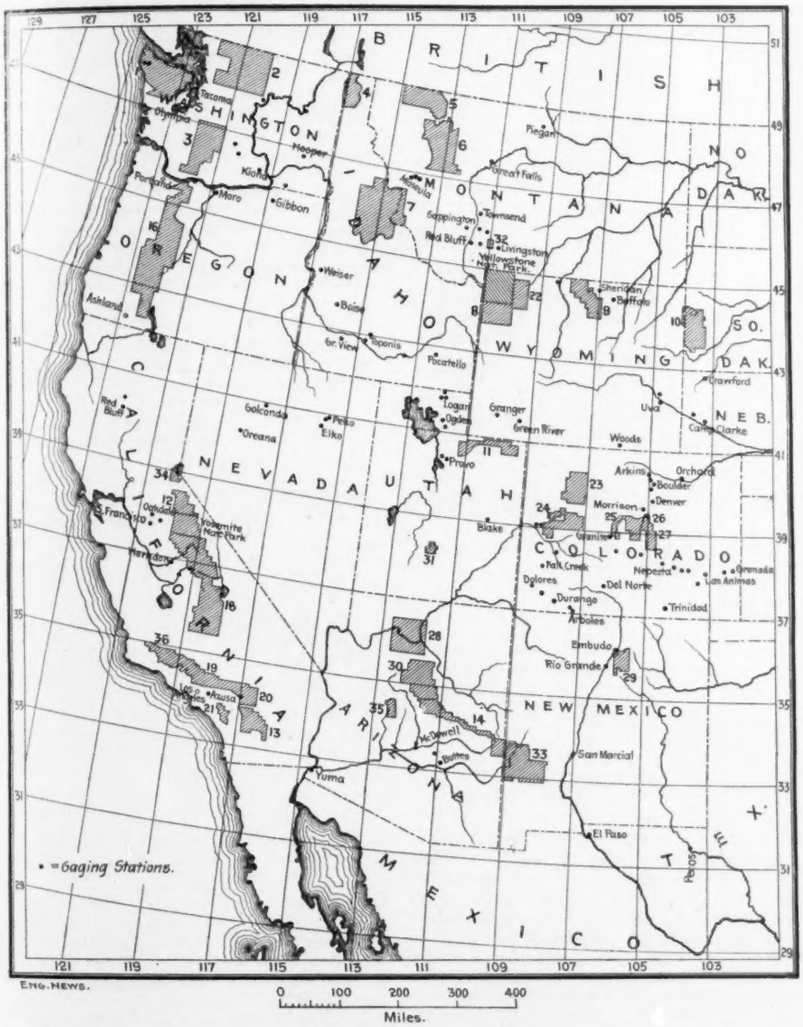
Assistant ship draftsmen, 1st class.....$3.28 per diem.
" " " 2d " ..... 2.80 " "

QUALIFICATIONS.—In addition to the requirements for third and fourth-class assistant ship draftsmen, to have an elementary knowledge of trigonometry. To be familiar with the use of tables of squares, cubes, etc. To understand the calculation of areas by trapezoidal and Simpson's Rules, and to be familiar with the rules for areas of circles, triangles, etc. To be competent to estimate the quantities of material in simple work and to calculate the capacity of tanks, bunkers, etc. To read drawings readily and to be able to make sketches from finished work and prepare finished plans and tracings from the same. In laying out drawings, to have ability to select the views, so as to give a complete understanding of the work with a minimum of labor. Good workmanship, as shown in the general arrangement and finish of plans. To have a general idea of how patterns and ordinary castings are made. To have a complete idea of the usual methods of subdivision and arrangements of framing, plating, etc. To have general ideas of the methods adopted in putting together and erecting the ironwork of a ship in the yard. To be able to develop detail plans from general sketches.

Ship draftsmen, 1st class.....$5.04 per diem.
" " 2d " ..... 4.48 " "
" " 3d " ..... 4.00 " "
" " 4th " ..... 3.60 " "

QUALIFICATIONS.—In addition to the subjects specified for assistant ship draftsmen, to be competent in the elements of algebra, geometry, and trigonometry, including the use of tables and logarithms. To have an elementary knowledge of strength of materials and calculations concerning proportioning simple structures. To understand the calculation of areas and moments by the various rules. To be competent to calculate the weight and center of gravity of any portion of the ship. To thoroughly understand the relations of the sheer, half breadth and body plans. To be able to lay off diagonals, harpins, inclined water lines, etc., and to be able to make all the ordinary calculations for displacement, tons per inch, wetted surface, C. B. meta-centers, trim, moment to change trim, calculations to complete inclining experiment, meta-centric diagram. To know the rules for riveting, determined by good practice, and to specify suitable scantlings for bulkheads, framing and plating, according to circumstances. To understand the methods and order of procedure in erecting work. To have sufficient ideas concerning the methods of shop and ship work to avoid uselessly costly methods and designs of fittings, plating, etc. To be able to lay out structural plans of a

settlement, called forth protests which resulted in enactment by Congress of legislation requiring the United States Geological Survey to survey and mark the bounds of such reservations as had been created by Executive proclamation and, if necessary, to make subdivision surveys under the Land Office rectangular system. The plats and field notes prepared by the Geological Survey were to be deposited with the General Land Office. Moreover, a topographic survey of the forest reserves was ordered to be made at the same time, and upon this was to be shown the distribution of the woods, their character and amount, and other information pertaining thereto. Finally, it was provided that such lands as might prove more valuable for mineral and agricultural than for forest purposes were to be withdrawn from



MAP OF THE WESTERN UNITED STATES, SHOWING FOREST RESERVATIONS AND STREAM-GAGING STATIONS.

1. Olympic.
2. Washington.
3. Mt. Rainier.
4. Priest River.
5. Flathead.
6. Lewis and Clarke.
7. Bitter Root.
8. Teton.
9. Bighorn.
10. Black Hills.
11. Uinta.
12. Stanislaus.
13. San Jacinto.
14. Black Mesa.
15. Bull Run.
16. Cascade.
17. Ashland.
18. Sierra.
19. San Gabriel.
20. San Bernardino.
21. Trabuco Canyon.
22. Yellowstone.
23. White River.
24. Battlement Mesa.
25. South Platte.
26. Plum Creek.
27. Pike's Peak.
28. Grand Canyon.
29. Pecos River.
30. San Francisco Mountains.
31. Fish Lake.
32. Gallatin.
33. Gila.
34. Lake Tahoe.
35. Prescott.
36. Pine Mt. & Zaca Lake.

reservation and made available for settlement. The stated purpose for setting aside forest reserves was to protect the forests and secure favorable conditions for water flow, and to secure a continuous supply of timber for the citizens of the United States. Finally, the act required the Secretary of the Interior, through the Commissioner of the General Land Office, to make provision for the protection of the forests against depredations and destruction by fire, and to establish rules which would insure the objects of such reservations. Also regulations whereby the use of timber and stone might be given free to bona fide settlers, miners and residents in the neighborhood, and whereby lumbering operations might be carried on under contract by such parties as should make proper payment for the privilege under such restrictions as would preserve and continue the life of the forest.

As a result of the above legislation, appropriations of from $150,000 to $250,000 per annum have been expended by the United States Geological Survey under its divisions of topography and forestry, in surveying and marking the bounds of the forests, making a topographic map of the same and in classifying the lands. The results are published in the various annual reports of the Director since that of 1898 and show in detail the amount of stumpage for the various kinds of merchantable timber and firewood in the areas surveyed and classified. The trigonometric and land surveys and the topographic mapping are executed by the topographic branch of the Geological Survey. The resulting maps are taken into the field the succeeding year by expert foresters in the employ of the forest division of the same organization, and upon these maps are indicated by numbers and symbols the location and stumpage by sections and quarter-sections, as examined in the field.

Nearly all of the 37 existing reserves have been already examined wholly or in part. These are situated in the public lands in the high mountain regions west of the Mississippi River. The results of this examination include a topographic map of 21,540 square miles within the bounds of the reserves and of 10,759 square miles immediately adjacent to such reserves, which it may be desirable at some future time to include in them by further Executive proclamation. The area triangulated in and adjacent to the reserves in order to control the boundary and topographic surveys, is 47,867 square miles. Most of the lands within the reserves was found to be wilderness devoid of land lines or astronomic triangulation positions, and it was necessary to establish these before the more detailed trigonometric and topographic surveys could be extended. In connection with the marking of the bounds of the reserves 2,052 linear miles of land lines have been run.

The classification of lands has been completed for 23 reserves, for which final reports have been published, which, in addition to partial examinations, makes a total area of 42,200 square miles, or over 58% of the total area. As this is the result of but three years of work, it is evident that within a relatively short time the surveys and examinations of these forest reserves will have been completed and the administration of all be in full force.

After the land line, topographic and land classification maps have been completed and filed with the Commissioner of the General Land Office, the administration of the forest land is taken up by his bureau. As at present established, this administration consists of three grades of foresters. The first includes 12 superintendents, each of whom is in charge of one or more reserves, about one to a State. The second are supervisors, of whom there are several to each reserve. The lower grade consists of several hundred rangers who patrol the forests with a view to detecting illegal cutting and to suppress fires or depredations by sheep, etc. Under the supervision of this force the privilege of grazing sheep is occasionally granted by special permit in such cases as it is believed will not interfere with the reproduction of the forests. An appropriation of $300,000 is made annually to cover the expenses of the administration of forest reserves. The cutting of timber above one foot in diameter is being quite generally carried on within the forest reserves under the supervision of the foresters, and the average rate paid for such privilege to the government is about one dollar per thousand. Among other restrictions attached to this privilege is one specifying that the tops, branches, etc., must be cleared off in order to reduce the danger of spread of fires.

Lumbermen in many portions of the West and settlers in general who at first opposed the withdrawal of these lands for purposes of forest reservations, now advocate and urge their extension. The lumbermen find it to their advantage to pay for the privilege of lumbering within the reserves rather than run the risk of illegal cutting on public or private lands without them. The stand of timber on the forest reserves is not yet fully estimated. Among those already examined a few have very little standing timber owing to the fires, etc., but will reproduce. Some have vast quantities of merchantable timber, that on Mt. Ranier reserve being estimated at 20,013,000,000 ft. B. M. and that on Olympic reserve 61,000,000,000 ft. B. M., an average of nearly 28,000 ft. per acre. It is evident that the extension of this great system of protected forests will add materially in the future to the value and life of the timber resources of the country. The annual cut of timber in the United States is about 25,000 million ft. B. M. The total stand on the government forest preserves is about 225,000 million ft. B. M., or nearly enough to supply the United States for ten years. Assuming that this would reproduce once in fifty years under proper supervision, these reserves might be capable of supplying nearly a fifth of the merchantable timber required in this country at the present rate of consumption.

(c) Drawing and Design.—Design a building suitable for a navy yard, to meet given requirements, including an elevation and floor plan. Enlarge one of the details of the building. Make a tracing of one of the pencil drawings and design a title for the same.
Schedule of marks:

Testimonials	10
Education and experience	30
Knowledge of building materials, construction and specifications	20
Drawing and design	30
Mathematics	10
Total	100

STRUCTURAL STEEL WORK DRAFTSMEN.

Copyist structural steel work draftsmen, 1st class	$3.28 per diem.
Copyist structural steel work draftsmen, 2d class	3.04 " "
Copyist structural steel work draftsmen, 3d class	2.80 " "

WRITTEN EXAMINATION.—(a) The written examination and all written forms filled out by candidates will be marked for composition, penmanship, spelling and punctuation.
(b) Problems in arithmetic up to and including cube root and including vulgar and decimal fractions, least common multiple and greatest common devisor.
(c) Problems in elementary trigonometry and in geometrical construction.
(d) Knowledge of riveting as regards size and spacing of rivets.
(e) Knowledge of properties of steel and iron.
Drawing.—Exercise in making a pencil drawing of a truss or girder from a free-hand sketch which gives dimensions, sizes of material and number of rivets. Make a tracing of the pencil drawing with lettering and title. To be marked for rapidity as well as for neatness and excellence.
Schedule of marks:

Testimonials	10
Education and experience	10
Written examination	20
Drawing and tracing	60
Total	100

Asst. structural steel work draftsmen, 1st class	$4.00 per diem.
Asst. structural steel work draftsmen, 2d class	3.76 " "
Asst. structural steel work draftsmen, 3d class	3.52 " "

Mathematics.—Problems testing accuracy and rapidity and involving a knowledge of arithmetic, algebra, trigonometry and their use in elementary applied mechanics. Problems in finding the moment of inertia and radius of gyration of sections.
Knowledge of the Materials of Construction and of Detailing.—The proportioning of riveted or pin connections in structures from given data and making pen and ink sketches of same. Knowledge of the physical and chemical properties of steel and iron. Knowledge of properties of and requirements for materials used in engineering construction. Knowledge of details of construction.
Drawing.—Exercises in calculating strains in simple structures from given data. Exercises in proportioning members of a structure from given strains and making a pen and ink drawing of the same. Exercises in the spacing of rivets.
Schedule of marks:

Testimonials	10
Education and experience	20
Mathematics	10
Knowledge of materials of construction and detailing	20
Drawing	40
Total	100

Structural steel work draftsmen, 1st class	$5.04 per diem.
" " " " 2d "	4.72 " "
" " " " 3d "	4.48 " "

Mathematics.—Problems in mathematics and mechanics involving a knowledge of arithmetic, algebra, geometry and trigonometry and including problems of the moment of inertia and radius of gyration and maximum bending moment and shear.
Knowledge of Materials of Construction, of Detailing and of Specifications.—Exercises in proportioning and detailing different parts of structures. Knowledge of the properties of steel and iron and other important materials of construction; allowable unit stresses; specifications for materials and workmanship; sketches of different details of construction.
Drawing and Design.—Computing strains and proportioning trusses, girders, etc., from given data, and designing in outline structures to meet certain conditions. Making a complete working drawing of a structure, or a portion of a structure, from given data or from calculated stresses and sections. Make a tracing of same.
Schedule of marks:

Testimonials	10
Education and experience	30
Mathematics	10
Knowledge of materials of construction, of detailing and of specifications	20
Drawing and design	30
Total	100

EDUCATION AND EXPERIENCE.—In marking for education and experience in examinations for draftsmen and assistant draftsmen on structural steel and architectural work:

(a) Allow a maximum of 50% for degree obtained in first-class technical college. Allow a maximum of 35% for degree obtained in an allied technical course.
(b) Allow for practical experience before or during college course 5 points per year; proportionately for less than a year.
(c) Allow for practical experience in structural steel or architectural work after college course the following maximum marks, as the case may be: 1 year, 15; 2 years, 25; 3 years, 35; 4 years, 40; 5 years, 45; 6 years or more, 50.
(d) If a candidate has a practical knowledge of a mechanical trade which will be of service to him in his work, allow a maximum of 20 points therefor.

Candidates who have prima facie a good theoretical technical training, but no college training leading directly to a degree, allow the following maximum marks for experience: 1 year, 30; 2 years, 45; 3 years, 60; 4 years, 70; 5 years, 80; 6 years, 85; 7 years or more, 90.
Competitors who have had little or no scientific education, but whose knowledge has been obtained through practice, allow the following maximum marks: 1 year, 10; 2 years, 20; 3 years, 30; 4 years, 40; 5 years, 50; 6 years, 60; 7 years, 70; 8 years, 75; 9 years or more, 80.

HYDROGRAPHIC AND FOREST SURVEYS OF THE UNITED STATES.

By Herbert M. Wilson.*

Prior to 1888 the United States Government had made little or no effort to determine the value of its water supplies for power, irrigation, industrial and urban uses. In October of that year, Congress created the irrigation branch of the United States Geological Survey, and made appropriation for the purpose of investigating the extent to which the arid region of the United States could be redeemed by irrigation and for the storage and utilization of waters for that purpose and the prevention of floods and overflows. The organic law, from which have grown the forest and hydrographic divisions of the United States Geological Survey, is dated March 3, 1879, and provides that the Director of the United States Geological Survey shall among other things make a classification of the public lands and an examination of the geological structure and mineral resources of the national domain. It is thus seen that a prime function of that Survey is the classification of all lands within the bounds of the United States. This requires the segregation of the land into such as contain economic minerals, also into forest, cultivable, pastoral and barren lands. Finally, as water is classed as a mineral and is one of the most important economic resources, a study of its distribution and the fluctuations of its amount, has been properly relegated to the United States Geological Survey as one of its fundamental objects.

In August of 1894, and at subsequent dates, specific legislation and appropriations have been made for gaging the streams and determining the water supply of the United States, including the underground currents and artesian wells, and this in all portions of the public domain regardless of the availability of the waters for irrigation alone. The various enactments above referred to are carried out by the hydrographic division of the Geological Survey, which includes a chief hydrographer and numerous skilled assistants. Under these are temporary employees who record gage heights, assist in the cross-sectioning of streams at gaging stations and in the survey of storage reservoirs, etc. Lastly, under an enactment of 1896, provision is made for the preparation and publishing in octavo form of special hydrographic papers on the distribution and methods of utilizing the water resources of the United States.

The annual appropriations for this work now aggregate about $100,000. To the present time there have been established 284 gaging stations, the distribution of which is shown upon the accompanying map. From this it will be seen that measurement is being made of the volume and character of the discharge of typical streams in every portion of the United States. At each gaging station the cross-section of the stream is remeasured at frequent intervals, the slope of the bed above and below the section which is sounded is frequently determined, while the heights of water on the gage rods is read at least twice a day. The velocity of the flow is determined at frequent intervals by means of current meters. The results of these examinations of the streams are computed in the office and are published annually, with statements of the areas of catchment basins above the gaging stations and estimates of the amount and ratio of run-off for each basin. It is readily seen that such data, resulting as they do from series of observations conducted through long periods of time, furnish all the important preliminary information needed by civil engineers in the study of water resources and supplies of whatever kind, either for city consumption, the supply of reservoirs or for utilization as power or in irrigation.

*U. S. Geological Survey, Washington, D. C.

In addition to this important work for determining the volume of the flow in running streams, the hydrographic division examines the topographic maps with a view to discovering the relation between cultivable lands and sources of water supply for irrigation; also the possible sites for storage reservoirs. Preliminary surveys are made of reservoir sites in the arid regions, and in some cases these have been followed by more detailed surveys and drilling to bed rock with a view to furnishing all the data essential to the determination of the practicability and cost of constructing the necessary dams. Finally, trial lines for canals with estimates of their cost are made to ascertain the feasibility of carrying water from running streams or storage reservoirs to cultivable lands.

The statutes of 1890 provided that lands designated by the United States Geological Survey as furnishing possible sites for storage reservoirs or for irrigation canals should be reserved from occupation and settlement. Under this and additional legislation the Geological Survey has selected and mapped a large number of reservoir sites which have been entered on the records of the General Land Office and are reserved from entry or settlement. Descriptions of these are published in several of the annual reports of the Director of the Survey. As a result of this enactment the timber culture and desert land acts whereby large areas of valuable government lands were occupied in earlier years were repealed. Finally, the hydrographic branch of the Geological Survey has carried on extensive detailed geologic and engineering examinations with the view of determining the extent and character of underground water supplies. Not only has it examined such supplies in the arid regions but also in the East. The bureau possesses two complete diamond drill outfits, and has published as a result of these investigations numerous reports on the extent, possible quantity and life of the more important artesian basins as well as water supplies for common wells. Upon maps accompanying these are shown in conventional colors the depth of the water bearing beds.

The results of the work of this division are published in the annual reports of the Director, which have been supplemented by 45 separate water supply papers. These papers include the results of several important special investigations as well as statements of the regular work of the corps of the hydrographic office. Some of the more important papers include three upon experiments with windmills, two on sewage irrigation, one on pumping water, and several on seepage water, underground waters, artesian wells, and on the water resources of various states.

Prior to 1891 the United States Government owned no forests other than such as were on public lands available for settlement under homestead, pre-emption and similar land laws. In that year the President of the United States was authorized to set apart public lands bearing forests, the same to be known as forest reserves. Under this act, President Cleveland, in September, 1893, established 17 forest reservations in the western States, aggregating in area about 17,500,000 acres. Other reservations or extensions of existing reservations have been made from time to time by Executive proclamation, until at the present date there are 37 forest reserves in the United States with an aggregate area of 72,800 square miles, distributed as shown on the accompanying map. This is an amount which exceeds in area the government forest lands of all Europe, exclusive of those of Russia, and equals in area the States of New York, New Jersey, Massachusetts and Vermont. Moreover, within the past few years as a result of legislative enactment an administration has been perfected which controls and protects these forests in manner similar to that employed in Europe and India for the conduct of government forests.

Until 1897 no effort was made to survey or care for the United States forest reserves. In that year, on the recommendation of a committee of the National Academy of Sciences, reserves aggregating 22,347,500 acres were set aside by Executive order. This wholesale reservation of forest lands, which would thus remove them from

Very complete sewer records are kept by means of large scale plans bound in volumes. These show the mains and laterals, house connections, manholes, names of owners and length of frontage, particulars of the assessments, and other information. Mr. Frank Siefert is Assistant Engineer in charge of the office of the sewer division. All sewage is discharged into the Ohio River either directly or by its tributary creeks, but although the question of purification or disposal of the sewage has been brought up more than once, no definite action has been taken and no particular attention has been given to the eventual solution of the problem.

STREETS.

Many street extensions have to be built as earth embankments, and sometimes with masonry retaining walls, in order to obtain practicable grades in the hilly portions. A considerable amount of paving is under contract and projected, including mainly asphalt and granite blocks, which are the materials most generally used on the business streets. Granite is used where there is heavy teaming. In the residence districts, brick and macadam are used, while on the very steep grades of the hill sides boulders are commonly employed. There is no wood paving, but the use of creosoted wood blocks and asphalt blocks is contemplated. The city engineer is also disposed to favor experiments with stone blocks dressed to a smooth surface on the upper side and laid with close joints, provided that the stone is of such character that it will not become slippery. Such paving has been tried in Chicago, but on too small a scale to give any definite conclusions, especially as it extends only over a part of the width of the street.

Tar and cement grouting are both used, and sometimes in combination on the same piece of work, so as to allow for changes of temperature and for the occasional tearing up of the pavements for underground work. Stone or cement sidewalks are almost universally used, with stone curbs, and asphalt-paved streets have a course of stone slabs at each side to form the gutters. In some of the outlying residence districts combined gutters and curbs of concrete are used. The city streets have 6-in. concrete foundations, and the street railways have 6 ins. of concrete ballast, which accounts in part for the generally good condition of the street railway tracks. These tracks have to sustain very severe treatment from the heavy traffic which is carried exclusively in four-wheel cars, and these are very hard upon the track.

The street railway track construction is subject to the approval of the City Engineer, and consists almost entirely of grooved girder rails laid upon wooden ties embedded in the concrete foundation of the paving, except in the outlying districts where concrete is not used and the tracks are laid upon broken-stone ballast. Formerly 8 and 6-in. girder rails were used, having a groove 1 × 1 ins., with both sides practically vertical and a very narrow surface outside the groove. This was found somewhat difficult to clean and very unpleasant for the passengers when the groove was clogged with hard or frozen dirt. The present standard is the "Trilby" 9-in. and 7-in. 100-lb. section of the Lorain Steel Co. This has a groove flaring out to the guard side, with a broad guard or wearing surface which is ¼-in. below the level of the running head of the rail.

The city has in all about 386 miles of improved streets, of which there are 23 miles of asphalt paving, 47 miles of granite block, 40 miles of brick, and 70 miles of boulders, the remainder being macadam. The repairs of asphalt paving are done by contract for terms of five years; repairs on other kinds of paving are made by the city.

STREET CLEANING.

The streets are well cleaned, this work being attended to by a special force of men in the "white wings" uniform which originated with Colonel Waring in New York. The Street Cleaning Department has a force of about 330 men, including about 40 street sweepers in the white uniforms. The equipment includes 130 horses, 48 mules, 45 one-horse wagons, 60 two-horse wagons, 15 sweeping machines, six two-horse sprinklers, two buggies, five spring wagons and one iron cart. Last year the appropriation was $200,000, which was not exceeded. This has been increased to $235,000, which will enable the work to be carried on six days per week, instead of five as formerly. The appropriation is allotted as follows: 50% for cleaning streets and alleys, 43.75% for removing ashes and garbage, and 6.25% for cleaning catchbasins and sewers. The hauling work done from May 12 to Dec. 31, 1900, included the following: 53,337 loads of ashes, 35,666 loads of dirt, 6,446 loads of catchbasin dirt, and 2,682 loads of garbage.

GRADE CROSSINGS.

Nearly all the railways enter the city on the street level, in the lower parts of the city, and very serious accidents occur from time to time, which bring up the question of the abolition of grade crossings. Owing to the hilly nature of the city and the broken character of its topography, a systematic elevation of the tracks would cause considerable interference with streets and drainage, and very little appears to be said about this method of eliminating crossings. The viaduct system carrying the streets over the tracks and leaving the latter undisturbed, seems to be given much more attention. As a result of a recent accident, a viaduct 1,000 ft. long over the grade crossing of the B. & O. S. W. R. R. and the C., C., C. & St. L. Ry. at Dodsworth Ave., has been proposed, and the Board of Legislation has appointed an engineer, Mr. J. E. Breen, to investigate the entire question and devise some method of eliminating the most dangerous crossings.

CANALS.

Through the city runs the Miami & Erie Canal, which serves a number of industries. This has a width of 40 ft. and a normal depth of 4 ft., but it is now being improved by building new masonry retaining walls and dredging to a depth of 5 ft. Several small low-level bridges are contemplated, fitted with vertical lifts operated by hydraulic power, the height of vertical lift being about 6 ft. The work of improving the canal bridges will be done by the city.

TESTS OF TEXAS AND CALIFORNIA FUEL OILS.*

By Howard Stillman, M. Am. Soc. M. E.†

The Southern Pacific R. R. Co. has used fuel oil in locomotive service for several years, and is extending its use in proportion to the supply of this class of fuel.

As compared with coal the following results have been obtained in evaporative tests made with both fuels in locomotive service. The engines with which the tests were made were of the same size and make and in similar service.

Service, passenger.	Fuel: Summerland & Los Angeles petroleum.	Fuel: Comax (bit.) coal.
Miles run	224	224
Mean number of cars in train	3.71	3.71
Weight of cars in train, tons	113.91	110.40
Actual running time, hours	7.55	7.63
Average steam pressure gage, lbs.	133	130
Temperature of feed water, deg. F.	660	660
Pounds water evaported	55,025	49,333
Gallons oil burned	775	...
Pounds fuel burned	6,040	8,043
Water evaporated per lb. fuel	9.11	6.19
Evaporation from and at 212° F.	10.96	7.41
Pounds fuel to evaporate 1 lb. water from and at 212° F.	.09124	.1349
Equivalent of fuel for equal evap., lb.	1.00	1.48
Ditto, by measure	*168.9	†1
Gallons water evap. per gallon oil	8.75	...
Miles run per ton	74.14	55.72
Fuel burned per hour	*100	†537
Total ton mileage	25,314	24,730
Ton miles per gallon oil	33.53	...
Ton miles per lb. fuel	1.191	3.074

*Gallons. †Ton.

The above items are from record of fuel tests made with careful attention to weights and measures.

Proximate analyses of the Comax coal are as follows:

	Per cent.
Moisture	1.90
Volatile combustible	27.08
Fixed carbon	55.38
Ash	12.50
Sulphur	3.14
Total	100.00

The fuel oil used in the test was a California product from the locality named, and ranging in gravity close to 16° Baumé, its flash point being about 240° F., fire point at 290° F. In practice it is taken at the weight of 8 lbs. per gallon.

The California oil varies somewhat in gravity, but the fuel oils obtained from the Kern, Los Angeles, Summerland, McKittrick and other fields are represented in the results above shown. They are all dark brown or black heavy asphalt oils, being more or less oxidized petroleums, very thick and viscid at temperatures below 60°, and can only be handled by use of steam-heating coils in the tank or around the pipes.

The grades of California petroleum are many and should not all be confounded with the fuel oil referred to. There is a wide range in quality for refining purposes, but by the term fuel oil we mean that it is supposed to be of use for little else than fuel, and this article deals more particularly with such oils.

As to the relative cost of either coal or oil fuel, the relative values are based on the figures from the above test for equal calorific effect from and at 212° F.; that is to say, 168.9 gallons oil equal one ton of coal, to which ratio local prices may be applied. As to the effect on flues, fire boxes, etc., there is rather more trouble with oil from leaky flues, seams, etc., than with coal fuel. This is due, not to the fuel, but to more rapid temperature changes in the fire box during service, with its subsequent expansions and contractions.

This applies particularly to the use of oil fuel in locomotives, because the service is so irregular in shutting off steam, stopping, starting, etc.

We have used oil fuel in stationary service many years, and it was used as fuel for a long time on the ferry steamers on San Francisco Bay, with excellent results, but was abandoned on account of possibility from accident on crowded boats and the timidity of the public. I had occasion, as a part of my duty, to make occasional inspection of the oil burning boilers of the steamers "Solano," "Oakland" and "Piedmont." I have never seen an instance of damage to fire-box plates from use of oil fuel. Stationary boilers, being regularly fired and not forced in evaporation as locomotive boilers are, do not suffer from the rapid expansions and contractions referred to.

THE TEXAS OIL.

The Texas fuel oil is in some respects quite different from the California oil. It has a gravity of about 22° Baumé, flashes at 180°, with the fire point at 200° F. Its commercial weight may be taken at 7.43 lbs. per gallon. It is quite fluid at ordinary temperatures, and flows easily and readily in pipes, burners, etc. For refining purposes it is said by authorities to be of little value and good for little else than fuel. A quantity of this oil was hauled into Los Angeles and put to use on a freight engine in comparison with the California product. The chief variations found were as follows:

About 2% gain in evaporative effect was found in favor of the California oil, but the probabilities are that with continued use there will be little or no difference found. Theoretically, the Texas oil has the greater calorific value, since it contains a larger proportion of the paraffine or unoxidized oils.

In the comparative test a marked difference was found in the effect of the oil fire on the brick lining and arch of the fire box. The California oils contain more or less water of a salty or alkali nature, the effect of the alkali being to flux and melt out the fire brick to such an extent that removals are quite an item. The Texas oil is free from alkali, and it was observed that no destructive element was present to destroy the fire brick.

The comparative fluidity of the Texas oil has already been referred to, and the difference in handling the oil was a matter of practical importance.

The smell of the burning oil or products of combustion of the Texas oil was noted by the locomotive engineer during his two weeks' experience with it. He said the odor was not as disagreeable as with the California oil. This was not as expected, because of the quantity of sulphur in the Texas oil, but is explained by the fact that in complete combustion the sulphur is completely oxidized.

The amount of sulphur in the Texas oil is considerable for petroleum, being from 1½ to 2½%. When the oil is distilled or heated below the ignition point without access to air, a series of sulphuretted gases are given off, which are very disagreeable. This is not the case when the oil is burned with plenty of air. Oil refiners cannot make use of the petroleums containing much sulphur, and condemn the Texas oil on this account for fuel.

I wish to contradict the statement made in an Eastern oil refiners' paper that "The Texas oil would eat up the flues of an ocean steamer in once crossing the Atlantic on account of the sulphur." This statement has no foundation in fact, and I would contradict it from the following basis of observation:

The Southern Pacific R. R. for many years used on a portion of its lines a quality of coal known as Union, or Comax. This coal contained sulphur in considerable quantities, varying from 3 to 5%. The sulphurous fumes were present in such quantity as to be objectionable to passengers and a general nuisance. Observations were made covering several years of the action of this coal on fire-box plates, but I was unable to locate corrosion that could be traced to sulphur. The reason why no such corrosion can be expected is briefly explained as follows:

The fumes of dry sulphurous acid at a high temperature are not corrosive to iron plates and cannot unite with them at the temperature of the furnace. In presence of water and at a temperature less, say, than the boiling point of water, the corrosive acid is formed in time, but this condition is not found in an oil fire.

*From the "New York Commercial."

†Engineer of Tests of the Southern Pacific R. R., Sacramento, Cal.

MUNICIPAL NOTES AT CINCINNATI.

The municipal government of the city of Cincinnati, O., is administered by a series of departments under the general direction of a Board of Public Service. The Engineer Department is in charge of streets, sewers and bridges; Mr. H. J. Stanley being Chief Engineer, a position he has held for a number of years. The Water Department has charge of the present water supply and distribution system, and has as its Chief Engineer Mr. Wm. H. Boeh. Independent of this is the Board of Trustees for the new water-supply system, now under construction (Eng. News, May 23, 1900); Mr. G. Bouscaren is Chief Engineer for the Board of Trustees. The street cleaning and collection of garbage are under the charge of the Street Cleaning Department of the Board of Publice Service; Mr. Fred. Maag is Superintendent of this department.

BRIDGES.

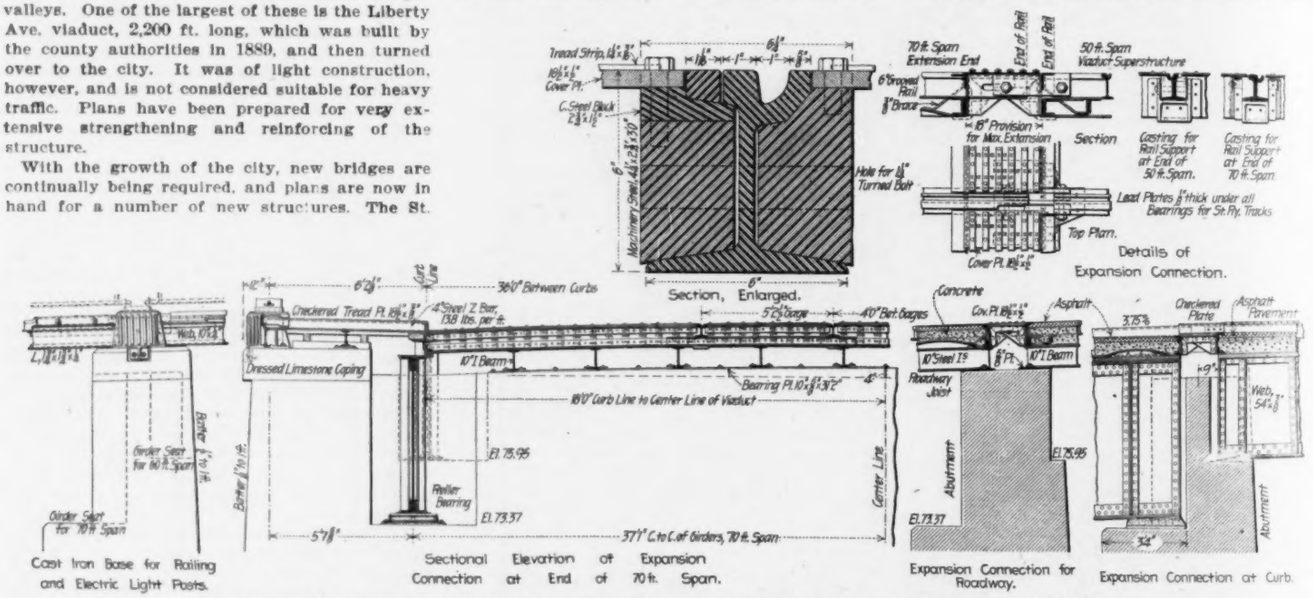
The topographical situation of the city is so irregular, being broken up by valleys running in various directions, that numerous bridges and viaducts are required. Some of these are comparatively short, while others are of considerable length, crossing the bottom lands of the larger valleys. One of the largest of these is the Liberty Ave. viaduct, 2,200 ft. long, which was built by the county authorities in 1889, and then turned over to the city. It was of light construction, however, and is not considered suitable for heavy traffic. Plans have been prepared for very extensive strengthening and reinforcing of the structure.

With the growth of the city, new bridges are continually being required, and plans are now in hand for a number of new structures. The St. Clair St. viaduct, between Eden and Euclid Sts., will be about 450 ft. long. The Harrison Ave. viaduct will be 1,489 ft. long, crossing the Mill Creek Valley and the B. & O. S. W. R. R. and C., H. & D. R. R. It will have a truss span of 180 ft. over Mill Creek, and 14 plate-girder spans of 40 to 100 ft. The grade will be about 3.75%. This viaduct will have a 36-ft. roadway and two 8-ft. sidewalks, the floor being of buckle plates covered with bituminous concrete, with asphalt paving for the roadway and cement concrete for the sidewalks. This viaduct will have double tracks for an electric street railway. The total cost, including right of way, is estimated at $250,000. Another bridge over the same valley will be at Spring Grove Ave., crossing the creek with a skew of 22° 50'. This will be 137 ft. 4 ins. long over the floor, with a span of 128 ft. 0¼-in. It will have three arched-deck trusses, carrying a 40-ft. roadway and two 10-ft. sidewalks. The rise of the arch is 14 ft. 3 ins., and its radius 150 ft. The trusses will be 17 ft. 9 ins. deep at the ends and 4 ft. deep at the center. Solid webs will be used for the two panels on each side of the center. There will be a buckle-plate floor, with asphalt roadway and cement sidewalks. The bridge will carry a double-track electric railway.

The Grandin Road viaduct, over Delta Ave., is to be 842 ft. long, or 935 ft. including the approaches. There will be five deck-truss spans of the Pratt single-intersection type; the center span will be 103 ft. above Delta Ave. The trusses will be supported by four steel towers about 45 ft. long. The floor will be of buckle plates and concrete, with a 34-ft. roadway paved with asphalt on bituminous concrete, and two 6-ft. cement sidewalks on a cement concrete base. A year or two ago a portion of the west approach of the Eighth St. viaduct was washed out by the breaking of a water main in the bank, the earth and the masonry retaining wall on the south side being carried away. The structure was temporarily repaired with wooden trestling, but it is now intended to extend the steel work 200 ft. to the west. There will be three deck plate girder spans; two of 70 ft. and one of 60 ft., built as a continuous girder. The roadway will be 36 ft. wide and the two sidewalks 6 ft. wide. The grade will be 3.75%. As this extension is at the expansion end of the original structure, an expansion of 6 ins. has to be allowed for, and a special form of expansion joint has been designed by Mr. F. E. Morris, Assistant Engineer in charge of the bridge division. This is shown in the accompanying cut.

The I-beam floor joists of the old and new parts of the viaduct expand toward each other on the stone abutment, resting on ⅝-in. bearing plates 10 ins. wide and 31 ft. 2 ins. long, secured by angle for support and attachment of the bottom flanges of the rails.

Expansion of street railway tracks is as follows. The ends of the rails for the 200-ft. extension extend over the 18-in. opening for expansion resting on steel castings attached to the channel sections with turned steel bolts. These castings have holes for the drainage of the opening between rails. The ends of the rails have 6 ins. space between for expansion, the ends on the 200-ft. extension being cut to halve with bearing pieces made of crucible steel 2¾ × 1½ ins., 3 ft. long secured to steel block supports for the splice, with six ½-in. cap screws. The rails will have steel blocks on each side, planed on all sides to fit the rails for support, and have cover plates for roadway expansion attached with cap screws each side of rails on the old part of the viaduct. The steel blocks are secured to the rails with two 1¼-in. turned steel bolts, and the rails at the end of the 200-ft. extension have slotted holes in the webs to allow for expansion. The sidewalks have checkered tread plates over the openings for expansion, attached to the old part of the viaduct and sliding on top of the new cement pavement. Expansion for sidewalk railings is provided for in the ornamental cast-iron posts for electric lights, and expansion for the outside of sidewalk or facia is provided for at the base of the same posts.


Details of Expansion Connection.
Section, Enlarged.
Sectional Elevation of Expansion Connection at End of 70 ft. Span.
Cast Iron Base for Railing and Electric Light Posts.
Expansion Connection for Roadway.
Expansion Connection at Curb.

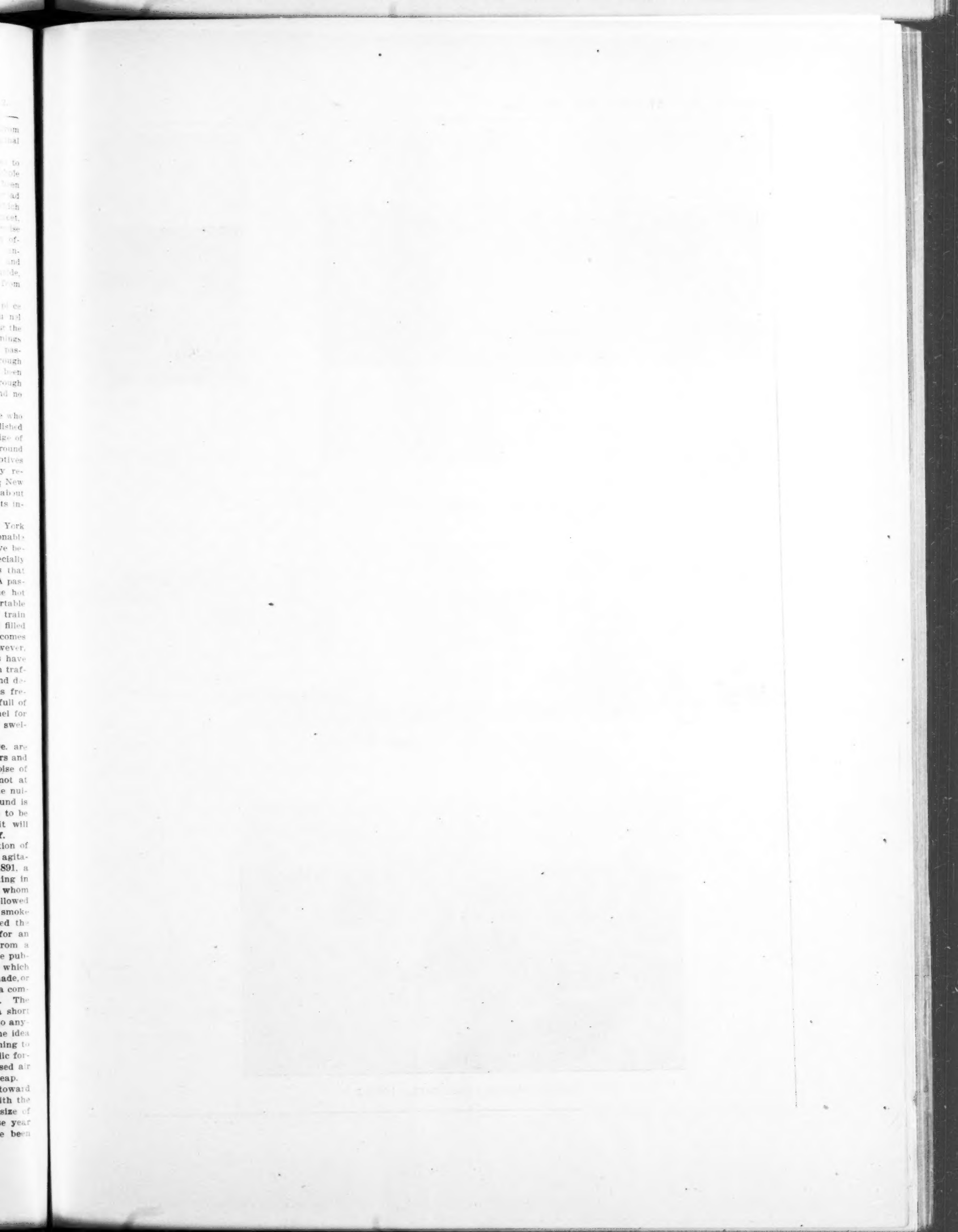
EXPANSION JOINT BETWEEN NEW AND OLD PORTIONS OF EIGHTH ST. VIADUCT, CINCINNATI, O.
(Expansion allowed, 6 ins.; old portion, 3½ ins.; new portion, 2½ ins.)

The anchor bolts, two at each bearing for the joists with lip washers to provide for expansion. The end sections for the pavement are composed of ⅜-in. web plates 10 ins. high at center of roadway, reduced at curbs 4 ins. for the crown of the roadway. Angles riveted to top and bottom make a channel section, with holes in the bottom angle for connection to the floor buckle plates. The space between the web plates of the old and new portions at ends of joists will be 18 ins., covered by a ⅛-in. steel plate 18½ ins. wide, with six lines of tread strips riveted to the top of the plates with ½-in. rivets countersunk on the under side to allow for expansion on the brackets attached to the 200-ft. extension. The cover plate expands on top of the end channel sections and the top of the asphalt pavement, and is supported on brackets composed of 5-16-in. web plates with angles bent and riveted to the plates. The brackets are spaced about 8 ins. c. to c. and are riveted to the cover plate and web plate of channel section at end of joists for the old part of the viaduct, which has 3½ ins. expansion. Brackets are riveted to the web plate only of the channel section at end of joists for the 200-ft. extension or new part of the viaduct, which has provision for 2½ ins. expansion. The channel sections at the ends of the pavement have braces or ties to the buckle plates from the top, to secure these plates where they are cut out for street railway rail openings, and angles 17 ft. 6 ins. long are riveted to the bottom

SEWERS.

Cincinnati has one of the largest sewers ever built in this country, this being the Lick Run trunk sewer. For a length of 2,300 ft. it is 20 ft. wide and 18 ft. high, with a five-ring brick arch, vertical side walls 5 ft. high, and a concrete invert paved with two rings of vitrified brick. For a distance of 1,500 ft. from Harrison Ave. to the mouth of the sewer, where it discharges into Mill Creek, it is of circular section, 19 ft. 6 ins. diameter, with a rubble masonry base or cradle built upon piles and grillage. Above the 18 × 20-ft. section, for a length of 5,042 ft., the sewer decreases from 13 ft. to 9 ft. diameter, with four to three rings of brick, supported by rubble masonry in bad ground. This masonry extends up to the haunches of the brick arch.

Outside of the ordinary brick and pipe sewer extensions, the most important work now on hand is the Bloody Run sewer, 2,300 ft. long and 12 ft. diameter inside. This will be built mainly in clay formation, and will have four brick rings, with a rubble masonry base, and brick side walls carried up nearly to the top of the arch, these walls being bonded into the outer ring of the sewer. The lower half of the inner ring will be of vitrified brick. The completion of the Avondale sewer system, for the benefit of the residence district on the hill, is also projected.



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ADVERTISING RATES: 20 *cents a line.* "*Want*" *and* "*For Sale*" *notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing* "*Want,*" "*For Sale*" *and* "*Proposal*" *advertisements are held open until Wednesday noon.*

The dangers of the St. Lawrence route for ocean steamers, and the handicap which this constitutes to the much-talked of competition of Montreal as an exporting port were discussed in our issue of March 28 and May 16. It is instructive to notice that two large steamers have been wrecked with total loss on the St. Lawrence route within the past three months, one of them being a vessel of the Leyland line, and the other the "Lusitania," of the Orient line, whose loss we noted last week. Such losses on any transportation route constitute in the long run a direct charge against the traffic which passes over it. In marine transportation this is particularly evident since the marine underwriters can only remain solvent by collecting at least enough insurance to cover the risk of loss.

A curious example of the contrast between the technical journalism of forty years ago and that of the present day, is brought forward in a paper entitled "Personal Recollections of Ericsson," contributed by Mr. Egbert P. Watson to our contemporary "The Engineering Magazine." As Mr. Watson tells the story, he was employed at the outbreak of the Civil War in the Novelty Iron Works, where the original "Monitor" was fitted with its turret, and became familiar with its construction. Shortly afterward, he became an associate editor of the "Scientific American," and wrote articles for that journal defending the principles and design of the "Monitor," in reply to the published criticisms which were then appearing. Some time afterward Ericsson sent word to Mr. Watson that he desired to see him. The account of the interview is as follows:

> Scarcely had I delivered my card and been ushered in when a noise was heard as of a ton of coal being violently thrown down stairs and Captain Ericsson rushed in holding out both hands. He said, in a voice like one hailing the main-top in a living gale: "You are Mr. W.! I am very glad to see you, sir; you have done me a great service, sir; Wait here, sir; I am very busy indeed!" and away he sped out of the room with the agility of a youth of twenty. Back he came in a very short time with a long yellow envelope which he thrust into my hand, saying, "Take that with my compliments, sir; I am very busy. Good morning, sir!" and ushered me out without further ceremony.
>
> The whole interview was, as one may say, extremely abrupt, my part in it being confined to saying "Yes, sir" and nothing more. Safe outside of the door, I carelessly tore open the envelope, thinking it had papers referring to the "Monitor," when, to my consternation, five $50 Treasury notes slid out on to the sidewalk. Being convinced that a mistake had been made, that in the haste of the moment the Captain had picked up the wrong envelope, I lost no time in ringing the bell again, with a request to see Captain Ericsson. He came down as before, in a moment, greatly perturbed in manner and speech.
>
> "What is the matter now, sir?" he demanded. "Why have you called me down again?"
>
> "Captain Ericsson, there is money in this letter, I thought it possible that you might have made a mistake!"
>
> "No, sir; there is no mistake. I do not make mistakes; nobody shall do me a service but what (sic) I shall pay him. Good morning, sir!" and he promptly thrust me out upon the door step again. Lost in speculation as to what manner of man it was that did business in so brusque and abrupt a fashion, I went back to my avocations and reported that Captain Ericsson had made me a present, omitting any details as to the amount of it. I was told to pocket all such insults, as mere business details. A repetition of the same affront from Captain Ericsson some weeks later did not seem to require a report.

The most interesting part of the above story is not the well-known eccentricities of Ericsson; but the candid admission that to the leading American technical journal of that day, the acceptance of a large and valuable present by a member of its editorial staff on account of articles which he had prepared for its columns was "mere business details."

We hardly need point out here how fatal any such practice and precedent must be to honest and impartial editorial utterance, nor how short a step it is from the acceptance of money for writing articles in defense of a certain interest to the acceptance of money for refraining from writing or publishing articles attacking it—which constitutes the crime of blackmail.

It will be said, we presume, that there are to-day plenty of so-called technical and trade journals, whose code of morals is no higher than that revealed in the above-related story. Admitting this fact, we nevertheless maintain that such journals are not the representative journals of the present day. Despite isolated instances of temporary prosperity, such journalism eventually reveals itself in its true character, and loss of prestige with readers and advertisers, and final failure inevitably follows. With the really reputable technical journals of to-day nothing is more strenuously insisted upon than the entire freedom of the reading matter pages from any suspicion of bias due to financial considerations.

THE VENTILATION OF RAILWAY TUNNELS UNDER CITY STREETS.

The railway lines which enter New York city from the north and have their terminus in the Grand Central Station at 42d St., pass through a tunnel about three miles in length, beginning just north of the Grand Central Station yards. This tunnel has to accommodate all the passenger traffic, both through and suburban, of the New York Central & Hudson River, New York, New Haven & Hartford and Harlem railways, and the total amounts to between 500 and 600 trains daily. The traffic through the tunnel is largely increased by the fact that the yards at the Grand Central Station are too small to store cars and locomotives to any extent, and hence a large movement of empty trains and locomotives running light has to be made between the station and the car storage yards north of the Harlem River.

The so-called tunnel is really three parallel tunnels, comprising a double track tunnel in the center, with a single track tunnel on each side, separated from the central tunnel by a masonry wall, pierced by a row of arched openings at the top, and by refuge passages at frequent intervals. The central double track tunnel has good-sized openings into the street above at frequent intervals; and these, with the arched openings from the side tunnels, were expected by the original designers to afford ample ventilation.

The tunnels, it will be understood, are close to the surface of the street above for their whole length, and the central tunnel could have been made an open cut with masonry walls instead of a tunnel. Park Ave., however, beneath which these tracks run, is a fashionable residence street, and the tracks were covered to keep the noise and smoke of passing trains from being an offense to the residents along the avenue. The ventilating openings are enclosed with railings, and are screened from view by shrubs planted inside, which survive the smoke and gases rising from the tunnel better than might be expected.

It will be seen that the designers of this piece of engineering work aimed to close the tunnel enough to avoid offense to the residents along the avenue, and at the same time leave openings enough to make the tunnel comfortable for passengers on the trains. With a small traffic through the tunnel, both of these things might have been accomplished. With the present traffic through it, the tunnel is a curse to the travelers and no small nuisance to those who live beside it.

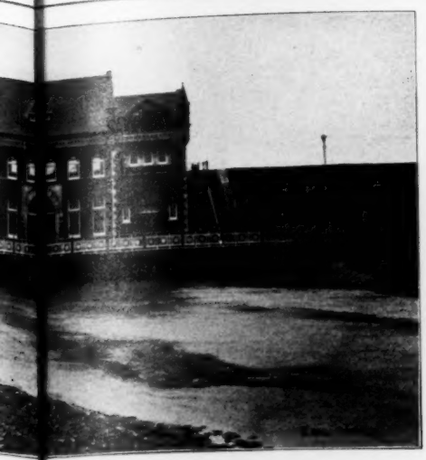
This much is to be said, however, for those who planned this tunnel. They followed the established precedent and did the best that the knowledge of that day permitted. The London underground railways which are operated by steam locomotives have provision for ventilation very closely resembling that adopted by the builders of the New York Central tunnel, and it may be added about equally the source of public complaint for its inefficiency.

It will be readily understood that the New York Central tunnel becomes much more objectionable both to the passengers and to those who live beside it, during the summer weather, and especially during any such extremely hot weather as that through which New York has just passed. A passenger car which has been standing in the hot sun in a railway yard is never very comfortable at best; but at most terminal stations the train passes out into the country as soon as it is filled with passengers, and the temperature becomes bearable. At the Grand Central Station, however, as soon as the train starts out all windows have to be closed until the tunnel is passed. With traffic so crowded as is the case here, blocks and delays are bound to occur with more or less frequency, and the condition of a car packed full of passengers which has to stand in the tunnel for five or ten minutes, or perhaps longer on a sweltering day, can be imagined.

Meanwhile the residents along Park Ave. are compelled by the summer's heat to keep doors and windows open, and the smoke, gas and noise of passing trains are offensive as they are not at other times of the year. So serious has the nuisance become of late that a subscription fund is being raised by residents along the avenue to be paid to the railway company, provided it will agree to abate the nuisances complained of.

This is not the first time that the condition of the tunnel has become a subject of public agitation. About ten years ago, on Feb. 20, 1891, a rear collision occurred in the tunnel resulting in the death of seven persons, at least two of whom were burned to death in the fire which followed the collision. Investigation showed that the smoke and fog which filled the tunnel so obscured the signals as to make it nearly impossible for an engine-driver to distinguish a red light from a white one. Following this accident, and the public condemnation of conditions in the tunnel which followed it, the railways using the tunnel made, or allowed to be made, some experiments with a compressed air scheme for tunnel ventilation. The apparatus was applied experimentally to a short section of one tunnel, and never amounted to anything practically, save to give the public the idea that the railway was actually doing something to remedy matters. In a few months the public forgot all about the matter, and the compressed air ventilating apparatus went to the scrap heap.

Since that time nothing has been done toward improving conditions in the tunnel, and with the increase of traffic and the growth in the size of locomotives, the situation has grown worse year by year. It is true that some tests have been



OUTH FRONT OF POWER HOUSE.

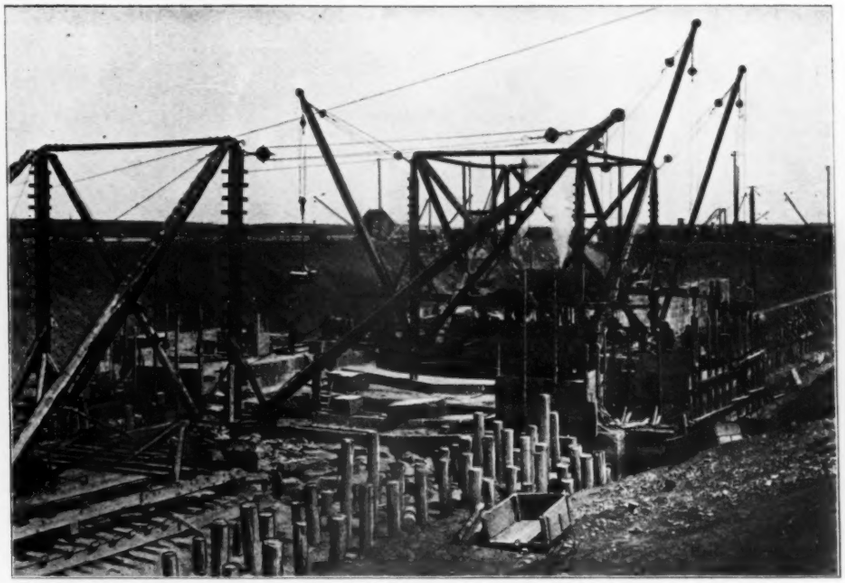


FIG. 16. VIEW OF LOCK 3, DURING CONSTRUCTION.

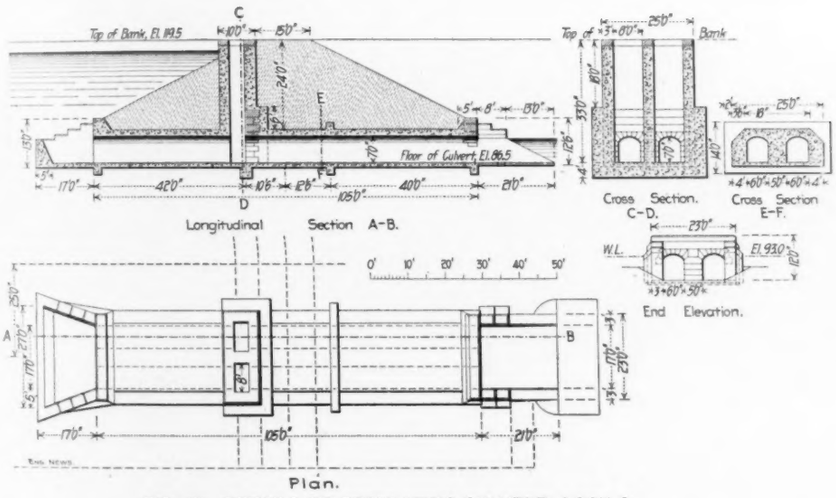


FIG. 17. DETAILS OF REGULATING CULVERT; LOCK 2.

FIG. 18. VIEW OF PONTOON USED FOR HANGING LOCK GATES.

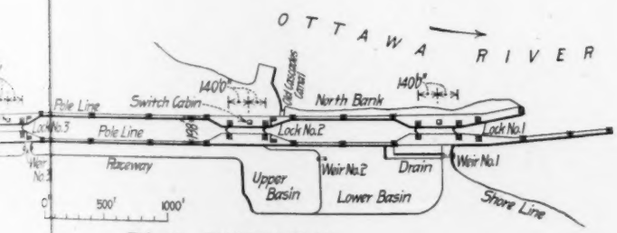


FIG. 13. DIAGRAM PLAN.

THE SOULANGES CANAL WORKS,
CANADA.

(Cascades Lock and Power Plant.)

Thomas Monro,
Engineer.

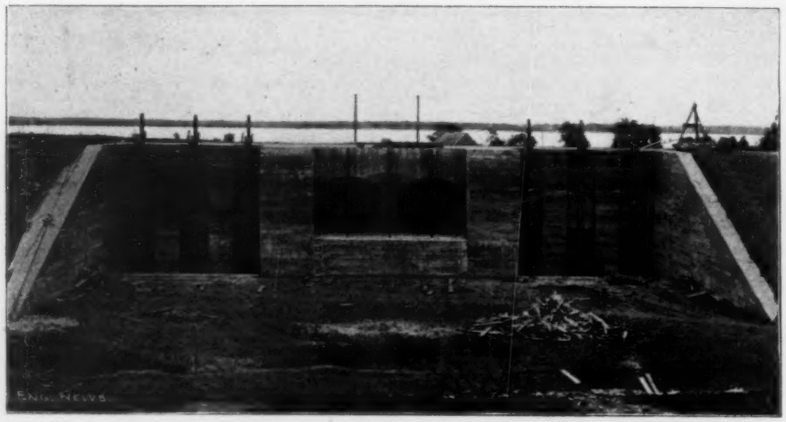


FIG. 19. VIEW OF POWER HOUSE DAM FROM CANAL SIDE.

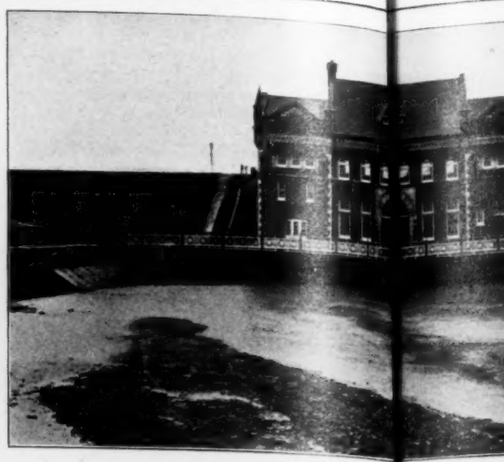


FIG. 20. VIEW OF SOUTH FRONT OF POW

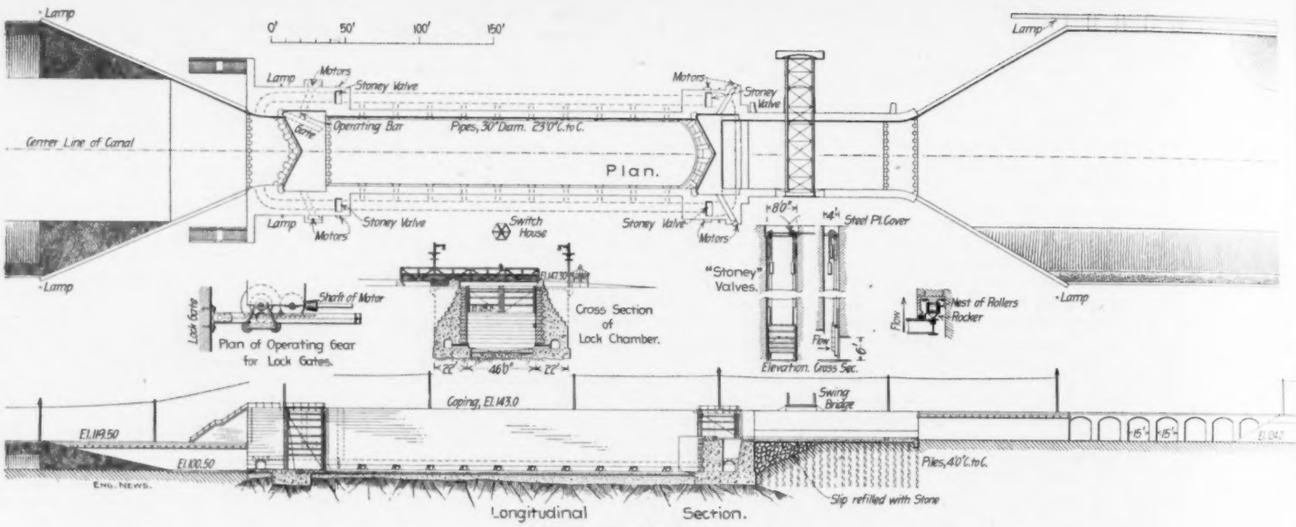


FIG. 14. DETAILS OF LOCK 3.

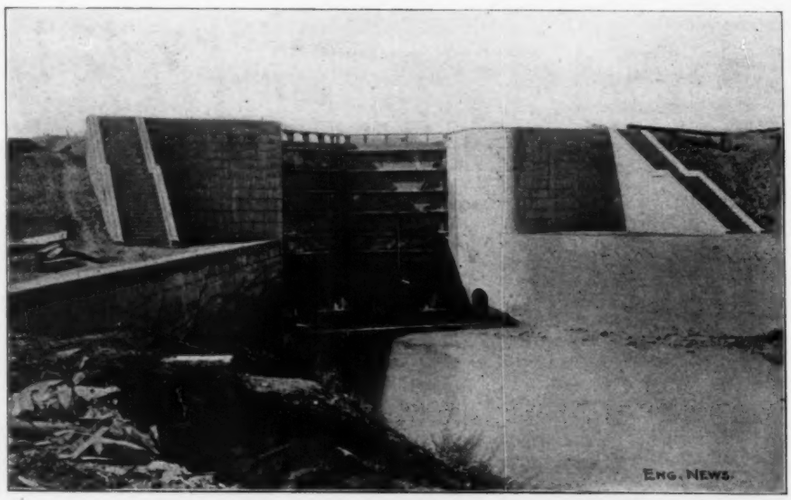
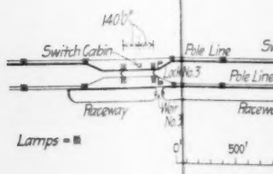
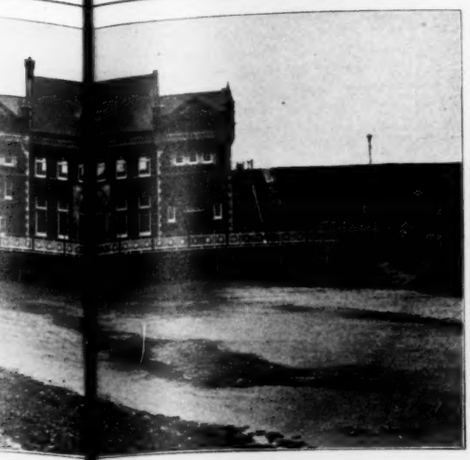


FIG. 15. VIEW OF LOWER GATES; LOCK 2.





V OF SOUTH FRONT OF POWER HOUSE.

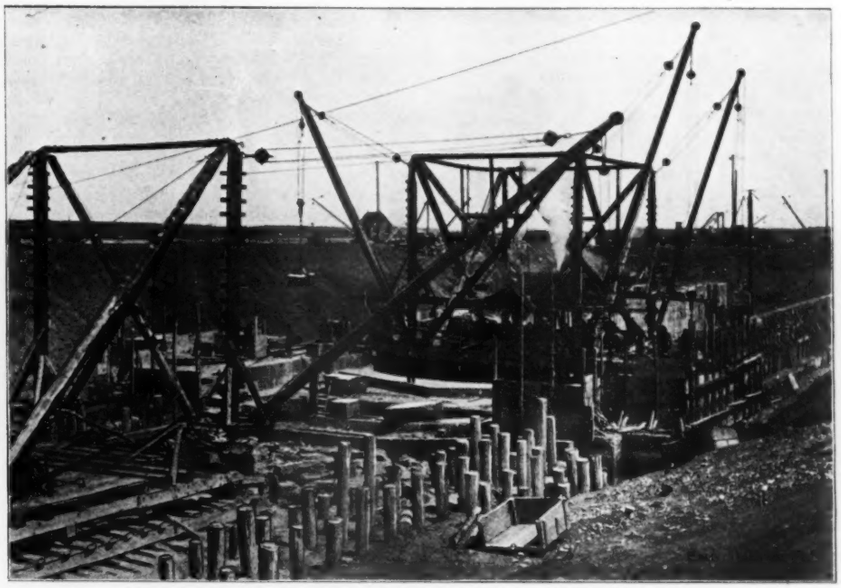


FIG. 16. VIEW OF LOCK 3, DURING CONSTRUCTION.

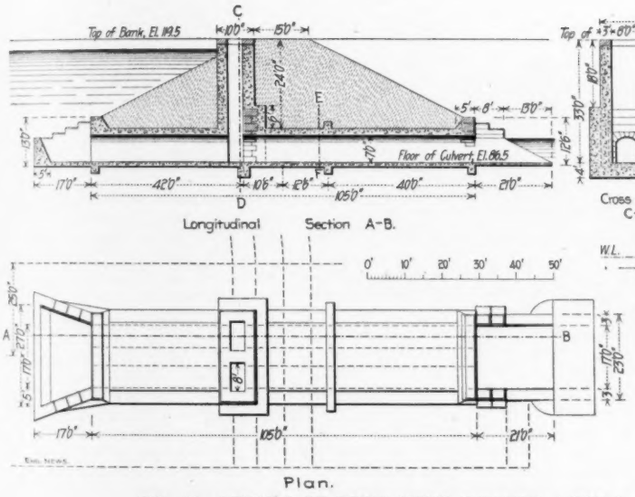


FIG. 17. DETAILS OF REGULATING CULVERT; LOCK 2.

FIG. 18. VIEW OF PONTOON USED FOR HANGING LOCK GATES.

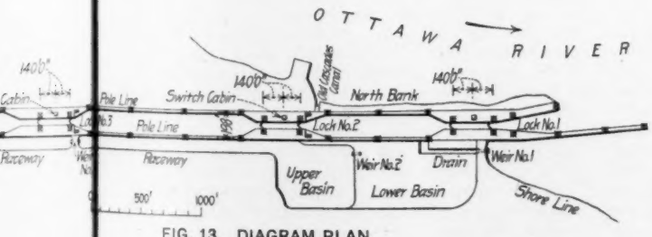


FIG. 13. DIAGRAM PLAN.

THE SOULANGES CANAL WORKS,
CANADA.

(Cascades Lock and Power Plant.)

Thomas Monro,
Engineer.

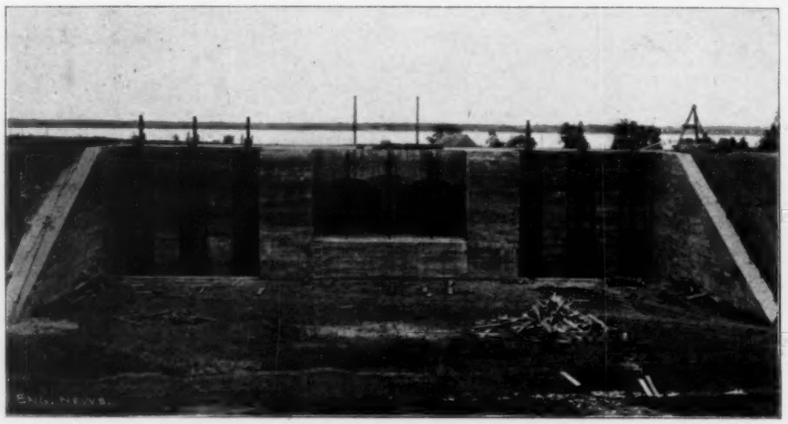


FIG. 19. VIEW OF POWER HOUSE DAM FROM CANAL SIDE.

FIG. 20. VIEW OF SOUTH [illegible] RONT O

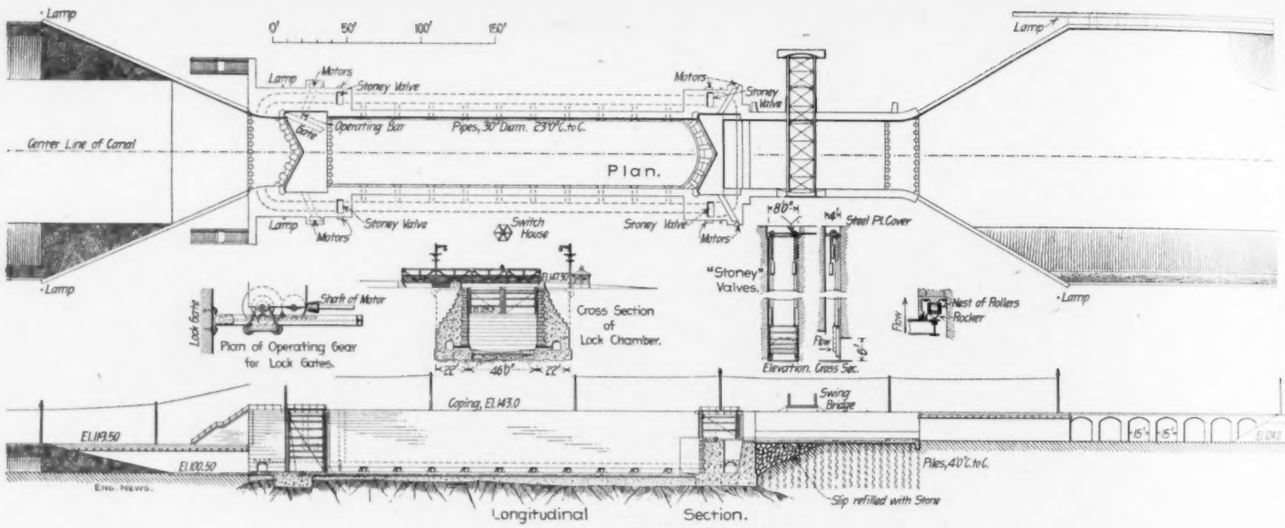


FIG. 14. DETAILS OF LOCK 3.

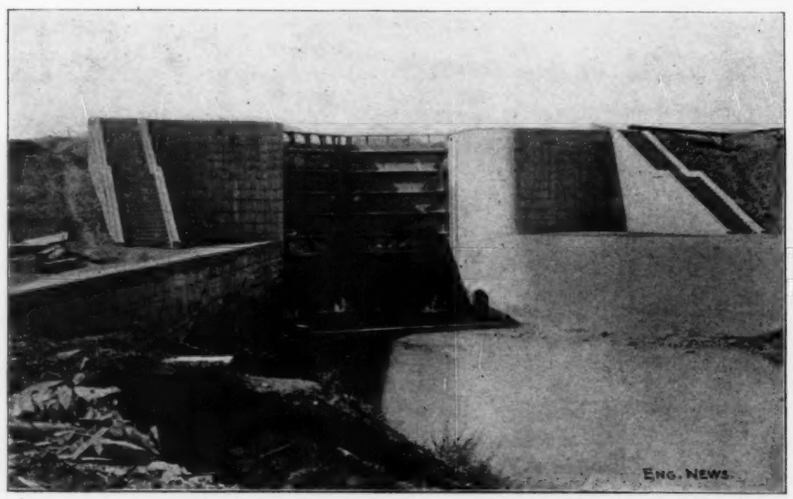


FIG. 15. VIEW OF LOWER GATES; LOCK 2.

made on the New York Central of a fireless locomotive, or hot-water motor, and we believe some of the officials have taken a sort of academic interest in the development of compressed air motor cars. Whatever the motive for these experiments, it is certain that their results give no encouragement whatever that a practical substitute for the steam locomotive can be found in either of these directions.

No compressed air motor or hot-water motor with a power approaching that of a standard steam locomotive has ever been built; nor has the success attained in the operation of small-sized motors on either of these systems been such as would justify any railway company in adopting either system in place of its regular locomotives.

Of course, the public turns at once to electric traction as a sure road out of the difficulty. The residents along Park Ave., subscribing to the fund above-named, have done so, we believe, in the expectation that the railway will be thereby induced to adopt electric motors for its trains. The "New York Times," in its issue of July 6, prescribes legal compulsion for the railway management, which it arraigns as follows:

> The position taken by the officers and engineers of the New York Central Railroad is in the highest degree discreditable. They maintain a hideous nuisance, they subject their passengers to atrocious tortures and actual danger of death by asphyxiation, and without shame put forth the plea that there is no relief, no remedy. To the end of time they must go on dragging their passengers through the awful tunnel.
>
> Further forbearance would be a vice. This dawdling corporation will never treat the public right until the public lays upon its shoulder the strong arm of compulsion. Accordingly, we here prescribe a cure for the tunnel abomination which we have not the slightest doubt will prove efficacious. Let the legislature at its next session enact a law that on and after a certain date no motive force requiring combustion in the tunnel shall be employed by the New York Central, Harlem, and New York, New Haven & Hartford Railroads between the Grand Central Station and Mott Haven. A reasonable time will be given, but after the date fixed in the act a failure to comply with its terms shall cost the delinquent railroad $10,000 a day. That is a little more than 3½% on $100,000,000—enough to give a powerful impulse to invention and discovery in the engineering department of any corporation.

Perhaps such a law might be passed; and it would be at least easy to have it introduced at Albany—where "strikers" are always ready for any attack on a corporation. It is doubtful, however, whether it would stand the scrutiny of the courts; and if it were actually carried into effect the traveling public and the city of New York would suffer even more than the railway companies.

Let us see if we can make this plain: Suppose that electric locomotives were adopted to haul trains through the tunnel. It is, or ought to be, evident that these motors would have to be changed and steam locomotives substituted at some point north of the Harlem River. Notwithstanding all the grandiloquent prophecies concerning the doom of the locomotive, of which the past fifteen years has been full, the fact remains that the electric motor cannot now compete with the steam locomotive for trunk line freight and passenger service, and no one at present can see any reasonable prospect that it can ever do so.

Now it seems a very easy thing to stop a train, take off one locomotive, couple on another, and go ahead, and it is—for one single train. When you have to handle, not one train, but five or six hundred in a day, however, and they are coming along at times faster than one a minute, the problem assumes very different proportions. We do not say it is insolvable; but it is clear that any such change would involve more or less delay to every train entering or leaving New York city by its most used gate of entry. A large yard would be required, protected by interlocking apparatus throughout; and the dangers of accident in any such yard, with all train movements made as rapidly as they would have to be, is something which deserves most serious consideration.

Again, how about the operation of the electric locomotives? Nobody could seriously suggest storage batteries for such heavy service, and overhead conductors have never worked satisfactorily for such large currents as would be required here. The original overhead system in the Baltimore & Ohio tunnel at Baltimore was finally discarded, and a third rail substituted. The third rail, however, has troubles of its own. Nobody has attempted to lay a third rail in any such complicated network of tracks as that between 42d and 50th Sts., or in such a yard as would have to be made for the change of motors above the Harlem. These things again, are matters of which neither the Park Ave. residence owners nor the legislators whom the "New York Times" urges to seize the bull by the horns are really competent to judge.

But must the passengers of the New York Central go on suffering "atrocious tortures" as the "Times" puts it, and must the Park Ave. dwellers take their air diluted with locomotive gas to the end of time? By no means. The remedy for the conditions complained of is to be found, not in any revolution in the system of motive power used in the tunnel, but in the adoption of a system of tunnel ventilation which will ventilate.

There is nothing experimental or doubtful or visionary about this. The application of power to move air is now as common and as well understood as the pumping of water, and the engineer can work in one field with as much certainty of success as in the other. At present the tunnel is constantly fouled by the discharge of frequently passing locomotives, and the only change of air is that effected by natural air currents, some of the time aided and some of the time hindered by the currents caused by the movement of trains. Such gases as finally escape from the tunnel are discharged at the street surface, where they are readily blown into the windows of houses on either side of the streets. This is hit-or-miss ventilation, and under the conditions existing in the Park Ave. railway tunnels, is a good deal more miss than hit.

Our contemporary, the "Times," is wrong in its choice of a remedy for the trouble in the tunnel; but it is right in its opinion that the nuisance can be abated, and that the officers of the company can find a way, if they will. Mr. Franklin, the manager of the Grand Central Station and tunnel, is quoted as saying:

> We have employed some of the most expert civil engineers in the world to solve the problem satisfactorily, and so far have failed to get at a satisfactory solution. It is not a question of expense with the New York Central, but a question of being able to do that which is best for both the road and its patrons.

It would be of interest to the public—or at least to the engineering portion of it—to know who were the engineers who "fell down" on this problem, and whether they were really given a fair limit as regards expense, and an opportunity to recommend the best as regards methods.

We have said above that the problem is really a simple one, and we are strongly inclined to believe that the New York Central engineers will be ready with a solution whenever a real demand for it is forthcoming from the management. The principles involved are really so simple that even a layman can grasp them: The foul gases ought to be discharged, of course, at the height of the chimney tops and not at the street level. This means the erection of shafts or chimneys over the tunnel openings. The flow of the gases up these chimneys and of fresh air into proper inlets to the tunnel, should be assisted by fans operated by electric motors. These inlets and outlets should be so disposed that the movement of trains in the tunnel will assist rather than retard the air movements. The air passages throughout should be made so large that great volumes of air can be moved with moderate velocities; if this is borne in mind, a moderate amount of power only will be required to operate the fans and to keep the tunnel reasonably clear of smoke and steam at all times.

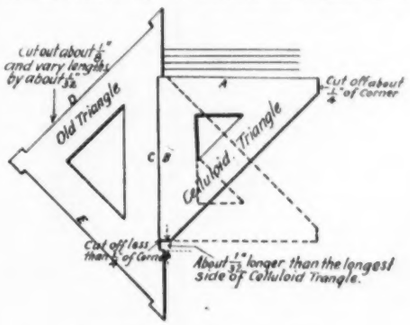
There is just one way to ventilate a room; bring fresh air in and carry the foul air out. The same rule applies to a railway tunnel. When engineers have failed in attacking matters of tunnel ventilation, it has been because they have handled the matter on too small a scale. The locomotive's throat is sixteen inches in diameter, and it discharges gas and steam from it at a speed of several thousand feet a minute. A great volume of air must be removed to offset this pollution, but if it is moved at low velocities this can be done with a very moderate consumption of power. As an illustration we may mention the ventilating apparatus of the Pennsylvania R. R. tunnel in the city of Baltimore, erected in 1892. Here a 45-HP. motor changes the entire volume of air in a double track tunnel 3,600 ft. long every five minutes, and discharges it from the top of a 100-ft. chimney. More rapid changes than this are doubtless needed in the Park Ave. tunnel, with its frequent trains, but they can be made with no extravagant consumption of power.

If the railways using the Park Ave. tunnel should provide for it an efficient system of ventilation, so as to render its atmosphere breathable, it is quite within the possibilities that the stimulus given to their suburban traffic might more than repay their expenditure.

LETTERS TO THE EDITOR.

A Simple Section Liner.

Sir: I enclose a sketch of a simple section liner, something on the order of the section liner Mr. Reinhardt describes in his excellent book on "Mechanical Drafting," p. 19. I think, however, it is an improvement on that You will observe that by changing the triangle in the


Cut out about ⅛" and vary lengths by about ⅛"
Old Triangle
Celluloid Triangle
Cut off about ¼" of corner
Cut off less than ¼" of corner
About 1" longer than the longest side of Celluloid Triangle.

A Convenient Section Liner.

three slots you can get a combination giving twelve different widths of spacing, enough, I think, to cover almost every case in practice. It will be found to give a very uniform spacing with a little practice. Respectfully,

Alfred S. Burgess.

Top. Dept., 3d Ave. and Tremont,
New York city, June 22, 1901.

Is the Draftsman a Worker at a Trade or a Professional Man?

Sir: Draftsmen cannot properly be classed as belonging to the engineering trade [sic], yet they may have some claim to consideration as workmen. Against my will, by the promotion of my "boss," I happen to be in the employ of the ..... Bridge Co. The consequence is that I cannot make a living in Chicago, unless I "pull up my stakes" and go to some other market. Being a foreigner, this is comparatively easy for me, but how many of your native draftsmen can do it? Is there any valid reason why draftsmen, like other workmen, should not have a union. Let me assure you that university education, as per Mr. Carnegie or luck as per Mr. Schwab, makes no difference in this case.

B. P. C.

Chicago, July 2, 1901.

(There are draftsmen and draftsmen. In fact, the word has nearly as wide a scope as the word "engineer." The draftsman at one end of the line, who begins as an office boy in the blue-print room and never rises above the level of a routine copyist, may well be ranked as a worker at a trade, for his occupation requires less originality and less breadth of knowledge than the work done by many an oil-smeared workman in the shops. At the other end of the scale is the draftsman who is a responsible designer, and whose work is as truly to be ranked with the work of professional men as that of engineers in any other capacity. Perhaps the copyists and tracers might better their situation by trade union methods; but the draftsmen at the other end could expect no benefit from any such source, and no one can draw a hard and fast line where the trade draftsman ends and the professional draftsman begins.

It is true, on the other hand, that employers do not always make the distinction they ought between the draftsmen who work with their hands and those who work with their brains, and the best men are too frequently underpaid. It is this class of employers who are most responsible for the envy with which draftsmen sometimes look toward the better paid union workmen in the machine shop.—Ed.)

Method of Calculating Beams for Concentrated Loads.

Sir: I beg leave to ask you to inform your interested readers that the method for "calculating size of beams for various locations and intensities of concentrated loads" contributed by Mr. E. P. Goodrich to your issue of May 23 is incorrect.

His construction is for determining that uniformly distributed load which is equivalent to the concentrated loads; or, in other words, that uniformly distributed load which would require the same size of beam, as determined by bending moment, as the concentrated loads require. His notion as to what constitutes the equivalent uniform load is wrong, as will readily be seen, I think, by

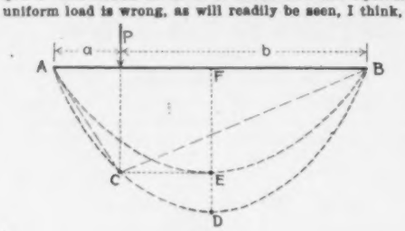


Fig. 1.

reference to a simple example. In Fig. 1 A B represents a beam on end supports, which sustains a single fixed concentrated load, P, and A C, C B the "curve" of bending moments due to P. Mr. Goodrich takes as the equivalent uniform load such an one that its bending moment curve (a parabola) passes through C. (His construction is for determining the point D.) But the equivalent uniform load should be such that its bending moment curve will pass through E. (A F = F B and C E is horizontal.) To express these two notions on equivalent load analytically, denote the maximum bending moment due to P by M, and the equivalent uniform load by W. Mr. Goodrich would compute W from the equation

$$\frac{W}{2}a - \frac{W\,a}{a+b}\,\frac{a}{2} = M,$$

whereas it should be computed from

$$\frac{1}{8}W\,(a+b) = M.$$

Using the correct notion of equivalent uniform load, the construction is considerably simplified. Fig. 2 is a substitute diagram for the same example employed by Mr. Goodrich.

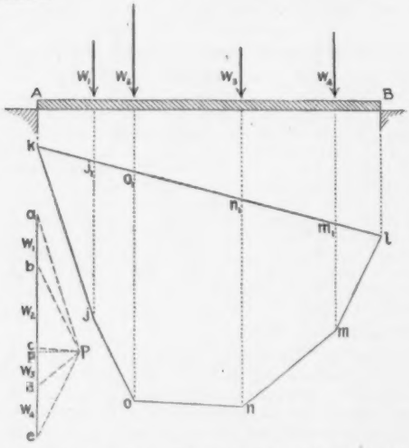


Fig. 2. Diagram for Calculating Size of Beams for Various Locations and Intensities of Concentrated Loads.

(Explanation.—Draw beam A B, loads w_1, w_2, etc., and verticals through same. Draw load line a e. Take polar distance P p one-eighth A B. Draw rays P a, P b, etc., and equilibrum polygon l m n o j k. Mark intersections of closing line and verticals through loads j_1, o_1, n_1, etc., then the greatest of the intercepts jj_1, oo_1, etc., represents the equivalent uniform load sought. Finally, size of required beam may be taken from hand-book tables using length of beam, and a uniform load equal to maximum intercept oo_1, measured by scale to which loads are drawn.)

If polar distance be taken equal to one-eighth A B, then the greatest of the intercepts mm_1, nn_1, oo_1, etc., represents, by the scale to which the weights are drawn, the equivalent uniformly distributed load. The maximum bending moment due to this load being equal to the maximum bending moment due to the concentrated loads.

A polar distance of one-eighth A B would often lead to an unsatisfactory equilibrium polygon. In such cases the polar distance may be taken equal to n A B, n being any number. Then, if the scale of the force diagram be 1 in. = x pounds, and the length in inches of the maximum intercept be denoted by i, (the equivalent uniform load, in pounds) = (8 n x) i.

If n and x be selected so that the numerical value of 8 n x is simple, as 1,000, 2,000, etc., no disadvantage results from not having taken the polar distance equal to one-eighth A B.

E. R. Maurer.

College of Engineering, University of Wisconsin,
June 1, 1901.

(The above letter was submitted to Mr. Goodrich, and we append his reply.—Ed.)

Sir: I think Prof. Maurer has been a little hasty in stating that my "method for calculating size of beams for various locations and intensities of concentrated loads is incorrect."

The "Explanation" of my construction, beginning at the eighth line from the bottom, reads as follows: "Center ordinate * * * gives uniformly distributed load, producing same bending moment as given loads *at point of beam over corresponding corner of equilibrium polygon.*" This is expressly what my diagram is for. Prof. Maurer is right as to the possibility of abbreviating my diagram where the idea which he thinks I have in mind is the one in question. Perhaps my letter of transmittal of April 12 was not couched in clear enough English, but in any case I am more than gratified that my contribution has at least been noticed.

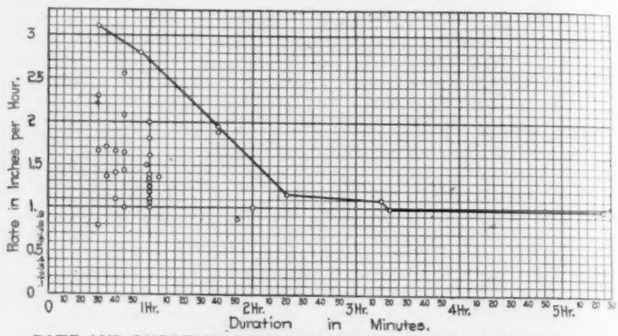
Yours very truly,

E. P. Goodrich, Civil Engineer, U. S. Navy.

U. S. Navy Yard, New York, June 12, 1901.

A Study of Maximum Rainfall Records for Use in Designing Paving Underdrainage at Mobile, Ala.

Sir: In the preparation of a comprehensive plan of underdrainage for the street paving contemplated by the city of Mobile, Ala., an interesting record of the rainfall for this section has been secured from the meteorological bureau established here. The bureau, I may add, was one of the first where regular and systematic results were recorded in the United States. This data has been plotted as shown on the accompanying diagram. Since 1872, the year when the local office was established by the Department of Agriculture, there have been only three occasions where the duration of rainfall exceeded a rate of 1 in. per hour and continued more than 5½ hours, the limit of the diagram. On one of these occasions, June 26, there was a most remarkable rainfall recorded, continuing for 10½ hours, at a rate of 1.19 ins. per hour, with an actual observed precipitation of 12.57 ins. Another abnormal fall is reported May 10, 1879, when in 10 minutes 1.64 ins. of rain fell, the rate of fall per hour being 9.84 ins. From the data secured, it may be interesting to report that the writer has determined upon 1½ ins. per hour as fall and duration assumed for his calculations; approximately, 1½ cu. ft. per second per acre. Respectfully,



RATE AND DURATION OF MAXIMUM RAINFALLS AT MOBILE, ALA., APRIL, 1872, TO APRIL, 1901.

J. N. Hazlehurst, M. Am. Soc. C. E.

Mobile, Ala., May 29, 1901.

Credit for the Design of the St. Croix Power Company's Dam.

Sir: The attention of the writer has been directed to an article which appears in Engineering News of June 13 entitled "A Concrete-Faced Stone Dam for the St. Croix Power Co., Wisconsin," which appears to be misleading in several particulars, prominent among which is the impression conveyed, perhaps unintentionally, that Messrs. Floy and Carpenter were the engineers and designers of the plant referred to.

This is not the first published statement of this tenor which has appeared in regard to this work, for on Nov. 23 of last year a paper was read by Mr. Henry Floy before the American Institute of Electrical Engineers entitled "The Plant of the St. Croix Power Co., of Wisconsin," of which the following paragraph forms a part:

> This paper would be incomplete without acknowledging the credit due to the writer's associate, Prof. R. C. Carperter, of Cornell University, for his assistance and co-operation in designing the mechanical and hydraulic plant.

Notwithstanding the fact that the attitude assumed in this and other statements was questioned at the time the paper was read, and the criticism made that Mr. F. O. Blackwell, Chief Engineer of the General Electric Co., was largely responsible for the electric end of the plant, the paper has been widely copied; and in view of the above, it would seem that some further explanation is necessary in the interest of fairness, as well as those members of the engineering fraternity who are content to base their reputations on their own achievements.

The writer has no desire to detract from whatever credit is due to Messrs. Floy and Carpenter, but the fact remains that they had nothing whatever to do with the design of the "mechanical and hydraulic," nor, in fact, of the electric features of this plant, except in one minor particular.

It may be added that due credit for all branches of the important piece of work has been given where it properly belongs in a descriptive article by the writer published in the February number of "Cassier's Magazine," from which I quote as follows:

> The complete plans for the plant were prepared under the direction of Mr. Robert N. King, of Dayton, Ohio. Mr. F. O. Blackwell, of the General Electric Co., rendered valuable assistance in connection with the electrical apparatus. Mr. H. L. Doherty, president of the Denver Electric Light Co., is also entitled to credit in connection with the work. Messrs. H. J. Gille, electrical superintendent, and Fred. R. Cutcheon, engineer, of the St. Paul Gas Co., had much to do with the design of the sub-station, and Mr. W. S. Morton, of St. Paul, had charge of matters connected with the right of way and pole line.
>
> The St. Croix Power Co. was incorporated under the laws of Wisconsin. Mr. A. P. Lathrop is its president and F. W. M. Cutcheon its general counsel; and Messrs. L. W. Rundlett, Henry Floy and J. W. Harper were employed by them to see that the work of construction was faithfully carried out.

It may be added that Mr. King and his engineers had no connection with the sub-station and electric lines within the city limits of St. Paul.

Very truly yours,

Charles L. Fitch.

Room 1214, 49 Wall St., New York city, June 17, 1901.

(A proof of the above letter was submitted to Mr. Floy, and we append his reply as follows —Ed.)

Sir: Please allow me to thank you for the privilege of replying to Mr. Charles L. Fitch's letter to you bearing on the engineering for the dam and other work of the St. Croix Power Co. of Wisconsin, for which I acted as engineer.

I will also take this opportunity to contradict the statements made in an article by Mr. Fitch appearing in the February issue of "Cassier's Magazine," which I have hitherto neglected answering because of the desire to avoid a controversy over personal matters, of no interest to the public.

In order to arrive at a more perfect understanding of the situation, it might be stated that Mr. R. N. King originally held options on the water power at Apple River Falls, and came to the people who afterwards organized the St. Croix Power Co., with a proposition to put in a power plant and turn the same over to the company complete with all real estate necessary. Accompanying this proposition were some general plans and specifications.

The St. Croix Power Co. then employed me as its engineer, with authority over the design and construction of the entire plant. In that capacity I prepared original plans and specifications, discarding for the most part those furnished by Mr. King, although adopting in my own, well-known systems and principles, and part of such standard apparatus as had been made the basis of Mr. King's proposal to the St. Croix Power Co.

On these plans and specifications prepared by me, a contract was made by the St. Croix Power Co. with Mr. King for the construction of the generating plant and overhead transmission line. That I was the responsible engineer for this work will be clear by the following quotation from the above-named contract, and its specifications attached thereto:

> FROM CONTRACT.—Mr. Henry Floy, of New York, N. Y., is hereby named by said party of second part (St. Croix Power Co.) as its engineer.
>
> Every device, piece of apparatus, machinery or material furnished or installed hereunder, and all work done hereunder, shall be subject to and shall be employed or used only with the approval of the engineer of said party of the second part. * * *
>
> In case any disagreement shall occur between the parties hereto as to the proper interpretation of any provision contained in the specifications attached hereto, or as to the significance or intent of anything shown upon the plans likewise attached, or as to the definition of any term, word, figure or expression used in or upon either of the same, the interpretation or definition of such provision, term, word, figure or expression, and the meaning of the said plan or plans, shall be determined by the engineer of the said party of the second part, and his conclusions shall be safe and binding upon both the parties hereto.
>
> FROM SPECIFICATIONS.—Any dispute or disagreement arising respecting the true construction, meaning or interpretation of the drawings and specifications, shall be

decided by the engineer whose decision shall be final, conclusive and binding on both purchaser and contractor.

Mr. Fitch, who was employed by Mr. King mainly in connection with securing rights of way for and construction of the transmission line, seems to feel that I slighted Mr. King in my paper before the American Institute of Electrical Engineers. His contention is perhaps not without ground, for I purposely omitted any reference to Mr. King and his sub-contractors, the Engineering Contract Co., in the published paper. The original draft of this paper did mention Mr. King and give him due credit for his connection with the enterprise, but at the time the paper was read, there was a law suit impending between the St. Croix Power Co. and Mr. King on account of the latter's claim that the latter had failed to carry out his contract (as a matter of fact, Mr. King did not perform some parts of his contract, which uncompleted work was performed by the power company under the personal supervision of the writer). My attorney, to whom I submitted the paper previous to reading it before the American Institute, advised me to leave out all reference to Mr. King, fearing it might be used by him to his advantage in the threatened law suit.

As claimed by Mr. Fitch, Mr. F. O. Blackwell, of the General Electric Co., may have rendered Mr. King valuable assistance in preparing his preliminary plans for the electrical work (Mr. Fitch has always represented himself as the author of such specifications as Mr. King furnished on pole line, we therefore presume his reference to Mr. Blackwell relates alone to the generating station apparatus) but the only specifications on the electric power plant which Mr. King furnished me was a copy of a proposal with the usual manufacturer's descriptive matter covering such apparatus as they desired to furnish him for the proposed plant. Overzealous and doubtless well-meaning but misinformed friends of Mr. Blackwell have made claims for credit due him, which he himself has never considered to exist. Suggestions or expressions of opinion on engineering questions from Mr. Blackwell, Mr. Doherty or engineers of their standing have been and always will be received by me with the highest appreciation and proper acknowledgment.

Without further discussion of the mis-statements originally made by Mr. Fitch in the article in "Cassier's Magazine" and repeated in his letter to you, I quote part of a letter received from the attorney and former president of the St. Croix Power Co., who is thoroughly conversant with all the facts in the case and not interested in this present controversy:

40 Wall St., New York, March 8, 1901.

Mr. Henry Floy, St. Paul Bldg., New York city.

Dear Sir: . . . The St. Croix Power Co.'s plant, so far as Mr. R. N. King had anything to do with it, consists of a dam, flume, power-house with hydraulic, generating and transforming apparatus and an overhead transmission line terminating in the outskirts of the city of St. Paul. This plant was built (except in some minor particulars) by Mr. King under contract with the power company. While the contract above mentioned was under negotiation, plans and specifications for the work contemplated by the contract were prepared under Mr. King's direction (by whom I do not know) and submitted to me. The plans were very general in character. The specifications were incomplete and in some respects did not meet the views of the power company. Thereupon the St. Croix Power Co. employed you as its consulting engineer. An attempt was made by you to modify Mr. King's plans and specifications so as to satisfy the wishes of the company. This, however, proved impracticable, and you were directed to draw up new plans and specifications, using such only of Mr. King's work as you should deem best. How much of Mr. King's work you embodied in yours I am unable to state without making a detailed comparison of the two sets of plans and specifications. I do know, however, that your work was much more elaborate than Mr. King's and differed from the latter in essential particulars as well as in a very large number of details. The contract mentioned was made upon the basis of plans and specifications thus prepared by you, which were attached to the written agreement.

The contract work, except as above stated, was performed by Mr. King as principal contractor. . . .

All of this construction work was actively and constantly supervised by you, as engineer of the power company, assisted by Mr. L. W. Rundlett, of St. Paul, as resident engineer, and Mr. J. L. Harper, as inspector of pole-line and electrical construction, both of whom were in your employ.

The plant located in St. Paul, and designed to supplement that above referred to (the high-tension underground cable installation, the sub-station in St. Paul and its apparatus), was constructed by the St. Paul Gas Light Co., the conduits and cables being turned over to the power company on completion. With this Mr. King had no connection. The plans for this work were made by you, assisted to some extent by Mr. H. L. Doherty, at present President of the Denver Gas & Electric Co., and by employes of the St. Paul Company, and the work was performed by the St. Paul Gas Light Co. under your general supervision.

As to all the work above mentioned, the responsibility to the power company and the gas company for the engineering of the enterprise rested entirely upon you.

These facts are all within my personal knowledge, as I was president of the power company until after the construction contracts were all made and have at all times mentioned been attorney for the power company and vice-president of the St. Paul Gas Light Co.

While my relations with Mr. King and all his representatives are entirely cordial, I have considered it but just that you should be given this statement for your protection. Very truly yours,

(Sgd) F. W. M. Cutcheon.

I trust the above evidence, which is only a part of what could be submitted, will convince any unprejudiced mind of my intended fairness and desire to include in the comparatively long list given in my American Institute paper, all those to whom credit is due for the success of the St. Croix Power Co.'s plant. Very truly yours,

Henry Floy.

220 Broadway, New York, July 6, 1901.

Notes and Queries.

W. M. H., Cincinnati, O., asks:

On small streams over which the United States has not or does not exercise jurisdiction, whose duty is it to regulate the minimum waterway section.

This is a matter which the respective states undoubtedly have the right to control; but so far as we recall legislation has been hardly attempted in this field and the common law respecting the rights of riparian owners has been allowed to govern the entire matter. Briefly stated, a man can do what he pleases with the bank of the stream which he owns; but if he diverts the course of the stream or narrows the waterway to the injury of an owner on the opposite bank or elsewhere, the latter party has his remedy in an injunction or a suit for damages. This system works fairly well so far as damages due to the action of streams at their ordinary stages are concerned. It is when great storms and floods occur, such as that at Johnstown, Pa., or that which recently swept through the Elkhorn Valley, in West Virginia, that the advantage of state control over water courses becomes evident. This will doubtless come in time as population and wealth increases just as it has come in densely inhabited parts of Europe.

THE EXTENSION OF THE WATER-METER SYSTEM is proposed in a number of cities. The city council of Syracuse, N. Y., has authorized a bond issue of $100,000, on the recommendation of Mr. John H. Moffitt, Superintendent of the Bureau of Water. At Norfolk, Va., Mr. W. T. Brooke, City Engineer, has recommended the expenditure of $109,000 for 8,000 meters, rather than $170,000 for a new supply main.

THE ELECTRICAL RESISTANCE of the human body from hand to hand has been made the subject of a series of experiments by Mr. W. L. Hooper, who has published the results obtained in the "Tufts Engineer." He finds that at high voltages there is a great diminution of the resistance. At 25 volts the resistance is 40,000 to 50,000 ohms, while at 100 to 125 volts it is only 1,000 to 2,000 ohms. He concludes that the diminished resistance is wholly or in part due to increased blood supply and activity of the sweat glands under the stimulation produced by the relatively large currents at high voltages. A similar falling off of resistance was not found in experiments upon dead animals.

TESTS OF COMMERCIAL ELECTRIC CONDENSERS manufactured by the General Electric Co. are given by Mr. C. P. Steinmetz in a recent article in the "Electrical World and Engineer." He connected the condensers in shunt with an inductance coil having the same reactance as the condensers, and then measured the power supplied to the combination by means of a wattmeter. As the energy consumption of the coil was known from an independent test with direct current, he was thus able to determine the losses in the condenser. His conclusions are as follows: (1) With a sine wave of impressed E. M. F. the current in the condenser is directly proportional to the impressed E. M. F. and to the frequency; that is, the capacity of the condenser on an alternating current circuit is constant, within the range of the tests. (2) The loss of power in the condenser is proportional to the square of the impressed E. M. F.; that is, the power factor of the condenser at constant frequency is constant and independent of the impressed voltage. (3) The power factor of the condenser does not seem to vary with the frequency; that is, the efficiency of the condenser appears to be independent of the frequency; or, in other words, the loss of energy per cycle is proportional to the square of the electro-static field strength, but independent of the frequency. (4) The power factor of well-made condensers is extremely low, averaging about .005, or the efficiency is about 99.5. The condensers tested consisted of tinfoil and paraffined paper, filled with paraffin by the application of heat and vacuum, so as to exclude air as far as possible.

ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

The ninth annual meeting of the society was held at Buffalo, N. Y., on June 29 and July 1 and 2, with about 35 members and guests in attendance. The programme comprised the reading and discussion of 21 papers and special committee reports, besides the regular routine business. The sessions were held in the lecture room of the Buffalo Law School, in the Ellicott Square Building. After some routine business, Prof. Frank O. Marvin, Dean of the Engineering School of the University of Kansas, the President of the Association, read his annual address, which was printed in our last issue. This was followed by a paper entitled "A Study of the Principles of Administration in Engineering Schools," by Prof. Olin H. Landreth, Union College; a paper on "Photography in Engineering Courses," by Prof. Joseph N. Bradford, Ohio State University, and a paper on "The Arrangement of Undergraduate Courses in Electrical Engineering," by Prof. John P. Jackson, Pennsylvania State College. The reading and discussion of these papers closed the work of the morning session.

At the afternoon session Prof. Charles F. Burgess presented a paper on "A Neglected Opportunity in Technical Education." In this paper the author urged the compilation of a suitable list of books on various branches of engineering and applied science for guidance to librarians in obtaining books for public and school libraries. The use of such a list of books would promote engineering education in placing suitable literature in the hands of those preparing for engineering schools, mechanics and workmen who are unable to take advantage of such schools, and the general public who are interested in industrial development. The next paper was by Prof. Charles L. Crandall, of Cornell University, and was entitled "To What Extent Should Modern Languages be Required in Engineering Courses?" Prof. Wm. M. Towle, of the Pennsylvania State College, then presented his paper on "How the Graduation Thesis Can be Made Most Effective in College Training." The following is a brief abstract of this paper:

The object of college training should be to prepare the student in the best possible manner for the active affairs of life. Near the close of the junior year the head of the department should explain what is expected for a thesis and the method of treating it, the student being strongly urged to choose his subject and put some thought, reading and observation upon it during the summer vacation. Soon after the opening of the senior year let the student be required to present for approval the subject of his thesis and the proposed method of treatment. This being a good opportunity to give a little professional training, the conduct of this work should be governed accordingly so far as possible. The instructor, when considering the subject with the student, should act as a consulting or chief engineer and not as an originator. He should require a clear statement of what is proposed to be done and approve, criticise or suggest, as the case may demand, and indicate where information and help may be found. By criticism and suggestions from the instructor this work can be made very effective in emphasizing the principles that have been brought out in the undergraduate studies and application of these can be made to the work in hand. After the preliminary work, let the student depend upon himself almost wholly, so that he will feel his responsibility. In working up the subject, let all the influencing conditions or factors be ascertained or assumed and then by reading, study and observation let the student find out what has been done and what is desired. With the conditions, actual or imposed, let him proceed to work out the best possible solution, always keeping both efficiency and cost in view.

The closing paper of the session was by Prof. Dugald C. Jackson, of the University of Wisconsin, and discussed the "Availability of Correspondence Schools as Trade Schools."

SECOND DAY'S SESSION.—The first paper of the second day's sessions was by Prof. Jas. C. Nagle, of the Agricultural and Mechanical College of Texas, and was entitled "The Danger of Excessive Specialization in Undergraduate Engineering Courses." In this paper the author advocated a more general training for undergraduate work, with a lengthening of the course by post-graduate work in special lines of study. The paper was discussed at some length, many of the members opposing the author's contentions with some heat. Prof. J. B. Johnson, of the University of Wisconsin, perhaps touched the kernel of the dispute, from a practical point of view, by stating that while engineering schools found it necessary as a business proposition to have a variety of special courses, the real difference between the schedules of study in many of these courses was very small. The next item in the programme was a discussion of the subject of "Graduation Requirements for the Bachelor's Degree in Engineering," which was opened by Prof. Wm. G. Raymond, of the Rensselaer Polytechnic Institute; Prof. Robert Fletcher, of Dartmouth College, and Prof. L. S. Randolph, of the Virginia Polytechnic Institute. Prof. Raymond advocated confining the work of the engineering school to engineering, giving a bachelor's degree for such a general course, giving a master's degree for advanced work in one or more directions, lengthening the school year and lessening the number of years in the course. Prof. Fletcher outlined at some length a general course of study leading to the degree of Bachelor of Science, with one year of post-graduate work, exclusively professional, leading to the degree of civil engineer or mechanical engineer. Prof. Randolph made no attempt to outline a course of study requisite for a student to receive an engineering degree, but urged the necessity of its being done and that the society formulate some definite standard of minimum requirements for different degrees. A paper on the "Present Tendencies in Technical and Industrial Education" was then read by Prof. J. B. Johnson, of the University of Wisconsin.

The afternoon session opened with a paper by Mr. Russell Sturgis on "Aesthetics in Engineering Design," of which the following is a short abstract:

Architectural art is largely a matter of tradition. In any very successful design of any epoch, tradition counts for a much larger part than does original thought. The main difficulty with modern architectural practice among

peoples of European stock is that there is now no general agreement as to the traditions which should be followed. The inevitable sequence was broken during the Revolutionary and Napoleonic epoch, and has never been recovered. Still, it is from old tradition restudied that modern work draws most of its best qualities.

Engineering is not matter of tradition, but of science. The engineer generally holds it his one duty to build in the most enduring and most economical way. If, however, engineering works are to be attractive to the eye, a tradition must build itself up, viz.: a tradition concerning that which is admissible and that which is not admissible. A structure which is very ugly must be recognized by engineers as not fit to be erected. The engineer must find ways to satisfy himself that what he proposes to build is as worthy to be permanent as it is sure to be permanent. The growth of such a tradition must of necessity be slow, but we may make a commencement. All traditions have begun in the successful innovations made by a few bold and original minds.

For the present, we had better make no attempt to improve such utilitarian things as railroad bridges, carsheds, grain elevators, piers and docks. It will be all that the present generation of engineers can hope to do to start a tradition of beautiful work in buildings planned for habitation and business. And for these the masonry building and the steel cage building must be carefully differentiated, for they present two radically diverse structures, each of which requires its own aesthetic study. Masonry building is solid and should look solid; the cage building must be sheathed and should look like a thin and slender thing, with a well designed boxing without and within.

This paper was not discussed, and was followed by a discussion on the subject "To What Extent and in What Direction is it Desirable for a Professor of Engineering to Accept Engineering Employment?" by Prof. C. Frank Allen, of the Massachusetts Institute of Technology, and by Mr. Wm. Kent. Prof. Allen's remarks were, in abstract, as follows:

The contemporaneous practice of engineering is often considered desirable for teachers of engineering, and for several reasons and from several standpoints. It is proper to consider this question with reference to the interests of the teacher himself, of his college, of the engineering and the general public and of the student. It may often happen that practice, reasonable in extent and in the right direction, will be of definite advantage to all these classes. However, it is not enough for the teacher that his practice shall prove advantageous to himself and to his college. If it shall prove disadvantageous, on the whole, to his pupils, it is not justifiable. The advantage to the pupils is the crucial test. After the proper immediate duty to the student is attended to there is still a question as to the best use of the remaining available time. Whether it shall be used in engineering practice, or in engineering investigation, or in maintaining contact with people both engineering and otherwise, is to be decided in part, perhaps largely, by individual temperament. Even here the value to the student of the course pursued should constitute an important element for the proper determination of the question. Throughout, the engineering professor is under urgent obligation to consult at all points the best interests of his students. While it may be necessary at times to run apparently or temporarily contrary to those interests, these should never be lost sight of, and should be conscientiously protected.

Mr. Kent regarded outside practice as not only justifiable, but advantageous, providing the professor did not intrench upon the time due to his students and maintained a proper standard of prices and work.

THIRD DAY'S SESSION.—At the closing session the following papers were read and discussed: "A Laboratory Exercise: The Calibration of a Riehlé-Gray Apparatus," by Prof. George R. Chatburn, University of Nebraska; "Irrigation in Engineering Courses of Instruction," by Elwood Mead, University of California and Irrigation Expert of the United States Department of Agriculture; "On Teaching Machine Design," by Forrest R. Jones, Worcester Polytechnic Institute; "Machine Work in an Engineering College," by William P. Turner, Purdue University; "The Summer School for Apprentices and Artisans at the University of Wisconsin," by John G. D. Mack, University of Wisconsin. Prof. Mack in his paper stated that the school had been established for the benefit of machinists, carpenters or sheet-metal workers; stationary, marine or locomotive engineers; shop foremen and superintendents; superintendents of water-works, electric light plants, power stations, factories, large office and store buildings in cities; and for the young men who wished to qualify themselves for such positions. For these employments the full four years' professional courses in engineering were not required, and yet to satisfy the present demands upon this class of men it is necessary for them to obtain considerable theoretical and practical knowledge not commonly taught in any of our schools.

RAILWAY TEST CAR OF THE UNIVERSITY OF ILLINOIS AND THE ILLINOIS CENTRAL R. R.

The railway test car designed by the officers of the University of Illinois and the Illinois Central R. R., and built at the railway company's Chicago shops, was described in our issue of Aug. 2, 1900, when we also published drawings of the dynamometer and recording apparatus. This car has been in operation since Sept. 1, 1900. We have recently received photographs of the car, with some particulars of its work and copies of its record charts, from Mr. Edward C. Schmidt, Instructor in Railway Engineering, at the University of Illinois, Urbana, Ill., and we give below his communication, practically in full.

It will be recalled that the car is fitted primarily for train-resistance tests and that it is equipped also with auxiliary apparatus for locomotive road tests and air-brake tests. The dynamometer consists essentially of three tandem cylinders, in one or the other of which the pull of the engine is taken against oil, by means of which the pressure is transmitted to the recording apparatus. The pistons of these cylinders are ground to as perfect a fit as possible and are unpacked, as are also the stuffing boxes. By this arrangement losses due to friction are reduced to a minimum. These cylinders are in communication with a recording hydraulic gage, which traces a record of drawbar pull. Some slight changes in the apparatus have been made since the drawings were published. The car is 45 ft. long and 9 ft. in width, mounted on a pair of four-wheel pasenger-car trucks. Fig. 1 is an interior view, looking toward the front end. The apparatus for the measurement of train resistance is placed on the table in the center. On it are the recording hydraulic gage and the paper-driving apparatus, together with the Boyer speed gage. On the gage board to the right of the table are placed the indicating hydraulic gage (used to standardize the recorder), the clock which controls the electrically-operated time pen, and a duplex air gage.

To the left of the table is a gage board on which are placed the two indicating steam gages and a recording steam gage, which are used during locomotive tests to measure boiler pressure and steam-chest pressure. In the foreground, on the right, are the pump, the oil and air pipes, and the valves, by means of which any one of the three dynamometer cylinders can be filled or emptied. Above the pump lever is a recording draft gage used in locomotive testing, and directly opposite it, on the other wall, is a recording air gage which records the pressures in the train line of the air-brake system. At the rear end of the car are four berths, the lockers and cupboards, the oil reservoir and the work bench. Under the table carrying the apparatus used in train-resistance tests is the gearing, driven from the car axle, from which motion is taken for the paper-driving apparatus and for the speed gage.

Upon the paper chart passing around the drum of the recorder are drawn four lines: the datum line, the line of drawbar pull, the location or position line (showing mile posts, stations, indicator-card positions, etc.), and the time line. The latter two lines are drawn at the top of the chart. Behind the recorder is the speed gage,

FIG. 1. VIEW OF INTERIOR OF TEST AND DYNAMOMETER CAR; UNIVERSITY OF ILLINOIS AND ILLINOIS CENTRAL R. R.

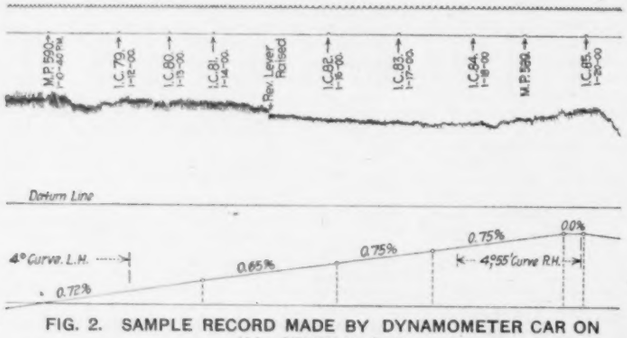


FIG. 2. SAMPLE RECORD MADE BY DYNAMOMETER CAR ON ILL. CENTRAL R. R.

(Test made Oct. 31, 1900, between Centralia and Mounds, Ill. Freight train No. 79; 48 cars; 1,839 tons. Diagram about one-fourth original size.)

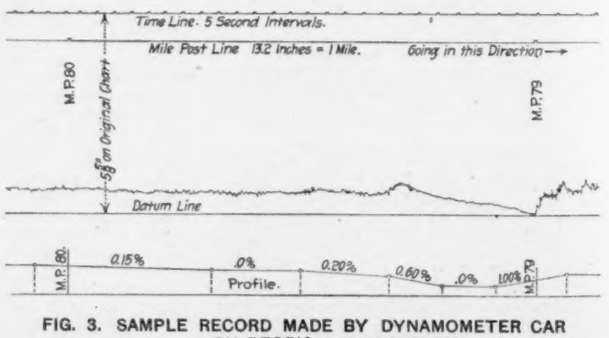


FIG. 3. SAMPLE RECORD MADE BY DYNAMOMETER CAR ON PEORIA & EASTERN RY.

(Test made April 12, 1901, between Urbana and Pekin. Freight train No. 91; weight 776 tons. Diagram about one-fourth original size.)

which is used simply to give a speed-record auxiliary to that given by the time line.

Figs. 2 and 3 are portions of two dynamometer records. Fig. 2 is from a record taken during a pulling test of an Illinois Central R. R. twelve-wheel locomotive, weighing 222,000 lbs., drawing a freight train of 48 cars and 1,859 tons weight, over a grade of about 0.7%. The section of the dynamometer cylinder used in this test was 80 sq. ins. The scale of the original chart is 13.2 ins. per mile or ¼-in. to 100 ft., which is the same as the ordinary profile scale. If necessary, this paper travel can be increased by changing one pair of gears in the paper-driving apparatus. Each inch in vertical height of the record corresponds to 247.6 lbs. per sq. in. in the dynamometer cylinder. The vibrations of the recording pen can be reduced by throttling the opening into the recorder, without impairing the accuracy of the record. This pen is ordinarily allowed to vibrate so as to give a curve such as the one shown in Fig. 2, the area under which can be very conveniently found by a planimeter.

The pen which draws the line just above the drawbar-pull curve is operated electrically by push buttons located in the lookout or observatory and in the small projecting windows at the front end of the car. By it are recorded the positions of the mile posts, stations and stops and also the points at which indicator cards are taken.

The pen which draws the line at the top of the chart is controlled by the clock, which makes electric contacts every five seconds. All calculations are based upon this time record, the record made by the speed gage being used merely to give the general character of the speed curve and to aid in interpreting the time record. Below the charts are shown the profiles of the portion of the road passed over during the test.

Fig. 3 is part of the record taken behind engine No. 501 of the Peoria & Eastern Ry. (C., C., C. & St. L. Ry. system). The train weight in this case is 776 tons in 20 cars. This record was taken during a test for the calibration of a dynamometer car, owned by the University of Illinois and the Peoria & Eastern Ry. (Eng. News, Nov. 24, 1898). This car is similar in essential arrangements to the car illustrated in Fig. 1, except that its single dynamometer cylinder has a cup leather-piston packing and also a leather stuffing-box packing. In this test, both cars were coupled together and operated in the same train for the purpose of determining the frictional resistance in these leather packings of the dynamometer car.

In addition to various train-resistance tests made with the test car, it was in operation during October and November, in a series of tests made on the Illinois Central R. R. between Centralia and Cairo, Ill., for the determination of the relation between the I. HP. and drawbar HP. of four types of freight locomotives in use on that district. It is at present engaged in a series of exhaust-nozzle tests between Champaign and Chicago, on the same railway.

The operation of the unpacked dynamometer cylinder, about whose success much doubt was expressed, has proved entirely satisfactory. The leakage of oil from the cylinders, even under sustained pressures of 700 and 800 lbs. per sq. in., has been so slight that no inconvenience has been experienced in keeping the cylinder full of oil. This leakage ensures perfect lubrication, and in no way prevents the full pressure in the dynamometer cylinder from being transmitted to the recorder, since the piston must instantly follow into the space vacated by the oil. Under continuous pressures of from 200 to 300 lbs. per sq. in. in the cylinder, they will operate without refilling for 2½ hours, during which time the piston will move forward (on account of the escape of oil) only 1½ ins.

FOUNDRY METALLURGY.*

By Herbert E. Field.†

Does it pay? This is the first and all important question that comes to every founder when considering the advisability of introducing chemistry as a branch of his foundry practice. It may be truthfully said that the amount of saving depends to a great extent, upon the class of work in which a foundry is engaged, upon its methods, and upon the men employed. A foundry melting ten ton a day can hardly expect to support an expensive laboratory, and a high-priced chemist, neither can a small laboratory, with an inferior metallurigst, make an appreciable showing in a large foundry.

Furnace men admit that foundries buying on specified analyses are getting the best of the product turned out from the furnaces. All furnaces make more or less poor iron, and this is very apt to go to the one who buys without specification. If you did nothing but to have a competent metallurgist furnish you with analyses best fitted for your work, and to insist that the furnaces send you iron which would fulfill these analyses, you would surely get a much superior quality of iron. The ability to make use of that grade of iron which can be bought cheapest at various times, enables a laboratory to add much to the credit side of the ledger. The founder who is confined to the use of one of two brands of iron, and who cannot profit by a low price quoted on some other iron, is certainly at a disadvantage in competition with a founder, who by use of his chemical methods can buy at the best prices the market offers. Irons frequently run better than specified, and an analysis of the car shows that it will carry more scrap, or more of a cheaper grade of pig iron, which may cause a considerable saving on that lot of iron.

Other arguments in favor of the laboratory are: the knowledge that a uniform product may be expected from your cupolas, the assurance that you will have no complaint from your customers, or from your machine shop on account of hard castings, and the saving which comes in machining these castings. The modern foundry now, more than ever, is called upon for castings to answer rigid specifications. Many foundries are compelled to reject such orders or have the castings made by others. Castings which will in every way answer the most exacting tests, formerly required of air furnace charcoal iron, can now be made from a cupola, by the use of analyses, at a cost exceeding but very little that of our ordinary castings. If the founder of cast iron hopes to hold his own against his steel competitors, he must be in a position to offer the best quality at a moderate price.

There are three methods open to foundries wishing to use foundry metallurgy. Each has its advantages and I mention them in passing to show that the small foundry need not burden itself with the expense of a metallurgist while the large foundries cannot expect to get the best results from the least outlay.

The use of furnace analyses as advocated by some writers on this subject is the cheapest method as far as the first outlay goes for mixing iron by chemical analyses; it is better than nothing. Especially is this true now that the No. 2 Soft and No. 2 Special irons have replaced the former No. 1 grade. These irons can be bought in some sections at a fairly low price, and if mixed by the silicon analysis, they may be frequently used with a considerable saving over iron graded by their fracture. There is absolutely no guide to the quality of these irons, except by analysis, upon which their successful use entirely depends. But little can be said as to the reliability of furnace analyses. I have known them to closely coincide with those made at the foundry, but frequently they vary, and the founder takes a chance in relying on this method. I consider it, however, an advantage in many cases over the fraction method. You at least have some definite specification to which you can hold your furnaceman; it is a step in the right direction.

The second method is the one which is meeting with the best results in the foundries of larger tonnage: The employment of a competent metallurgist with a suitably equipped laboratory, and with sufficient assistance to enable him to assume the whole care of the iron. Foundries engaged in special work will reap the greatest advantages from the successful laboratory.

There is, however, a third method open to foundries who do not consider that their work warrants the establishment of a laboratory, viz.: the employment of a metallurgist by a number of foundries. This has met with some success. It certainly has the advantage of saving the expense of the laboratory. To a certain extent, also, it is a saving in salary, for chemists can be employed at a much lower salary than metallurgists, and a laboratory with one competent metallurgist at its disposal, who is not hampered by the detail of analytical work, should be able to successfully care for several foundries.

CONDITIONS NECESSARY FOR THE ADVANCEMENT OF FOUNDRY METALLURGY.

One has but to read some of the recent articles on this subject to find out how small an advance has really been made. One authority asserts that silicon is the only element that can possibly effect your product, or that at most, a knowledge of silicon and sulphur is sufficient to enable you to accomplish all that can be wished for in the perfection of your castings. The next writer as confidently asserts that carbon is the only element which can in any way effect iron, and he tells how unnecessary it is to pay any attention to the other impurities. Again we seek, and are told that shrinkage alone is necessary in the controlling of our mixtures, and we are to simply cast a few test bars each day, and to use a certain machine for testing them, and all that we have been looking for, even perfection itself, is at hand. The harmful effects of these statements can be fully appreciated by the chemist who, coming to our foundries from a technical or industrial school, attempts to follow the directions written by men who are supposed to stand high in foundry matters. He had much better start with nothing to guide him than to attempt to fathom such contradictions and false statements. Those who know the least about foundry metallurgy seem to have written the most.

Another great drawback to the advancement of metallurgy in our foundries has been the poor preparation which chemists have received in our schools and colleges.

Inaccurate analyses furnished by second-class laboratories, poor methods of sampling, a lack of knowledge of the needs of the foundries by the furnaces, and a lack of appreciation by our foundries of the conditions which surround the making of the pig iron, are but a few more of the hindrances which foundry metallurgy is overcoming in its efforts for complete success. The standardizing bureau of this association has done much to overcome discrepancies in the results of different laboratories. I understand that an effort is being made to bring together into an association, all the metallurgical chemists connected with our furnaces and foundries in the hope of overcoming some of the differences which now exist between the makers and users of pig iron. Next to the good which might be accomplished by investigation in our schools, there is nothing which would be of more value to metallurgists than such an association. It deserves all the help that you can give it.

THREE QUESTIONS TO SETTLE.

(1) Can two irons of the same analysis and of different properties exist. If so how?

It is possible to have two irons of identical analysis, and yet of a very different physical structure. This statement is one most frequently brought forward by those who oppose the mixing of iron by chemical analysis. If two irons of identically the same analysis and different physical properties can exist, there must be a reason. This reason lies partially in the inability of chemical analysis to distinguish between different allotropic forms of the same substance. For example, we have the diamond, graphite, and amorphous carbon, all of entirely different physical properties, yet when treated by chemical methods, all give the one element, carbon. Silicon is known in two and possibly three modifications as are also sulphur and phosphorus. In fact, the very elements with which the chemist has to contend in cast iron, are the elements subject to such modifications. The difference in condition of these elements is wholly due to differences in heat treatment, hence the variation in physical structure in two iron of the same analysis must also be due to differences in heat treatment surrounding their formation.

(2) Can coke iron be substituted for charcoal iron?

Another subject which has caused many arguments, is that of the substitution of coke iron for charcoal iron for many foundry purposes. Can one be used in place of the other with the same result? This question can be answered in the affirmative, but it must be followed by rather a large "if." There is no doubt that with a proper selection of ores, using washed coke, and a careful attention to the detail of temperature in melting and casting, this might be accomplished. Many brands of charcoal iron are now readily duplicated in those of the coke furnaces. This is especially true of those grades advertised for their high tensile strength. A combination of coke iron can generally be made by analysis, which will exactly duplicate this charcoal iron. It is more difficult to duplicate the higher carbon irons used in the manufacture of car wheels, but even this has been equalled by the coke bessemer which is used for malleable purposes. The higher prices commanded by charcoal iron, enable a more careful selection of ores than is possible with coke iron. The use of coke iron in place of charcoal iron began extensively during a time when the coke furnaces were willing to meet any possible requirement in order to obtain contracts. This anxiety to fulfill narrow specifications entirely disappeared with returning prosperity, and gave way to a rush for tonnage which forced many founders who were having considerable success in the use of this iron, to return to those of the charcoal furnaces. The substitution of coke for charcoal iron lies to a considerable extent, with the furnaces themselves. The same care must be taken in the production of this iron which is exercised in the manufacture of our best Bessemer. It is probable that for a time demand would keep the price so near to that of charcoal iron that there would not be as much gain as might be expected to the founder.

(3) Are silicon and sulphur sufficient guides in the mixing of iron by chemical analysis?

The advocates of this method have been men engaged in a limited line of work, and employing a limited variety of irons. If one is using Bessemer iron only, and is making but one line of work; and if he is so situated that he uses the product of a single neighboring furnace; in such a case I may safely say that silicon and sulphur analysis will be sufficient guides in mixing his iron. The same might be true for any foundry using a limited number of high-class irons for a definite line of work.

The per cent. of silicon and sulphur necessary to control irons of one kind will be wholly unsuited for those of another kind. An instance recently brought to my notice will perhaps make this clear. A chemist went from an Eastern foundry where Virginia and Alabama iron had been used to a foundry in a different section of the country where Northern pig was principally melted. While awaiting the arrival of a carbon apparatus he analysed the iron for silicon and sulphur. He made his mixtures with the same per cent. of these elements that he had formerly used with such good results. His iron came soft, kishy and full of blow holes. It appeared to be right as it came from the furnace, but it soon became thick; feeding rods were covered with a kish-like compound. This caused no end of trouble. Upon analysis of these irons for carbon, they were found to run much higher than any that he had used in the East, and he was obliged to greatly reduce the silicon before this difficulty was overcome. Had he made the analysis for carbon first he would have avoided this difficulty and have saved much expense.

*From a paper read at the annual meeting of the American Foundrymen's Association.
†Ansonia, Conn.

The amount and condition of the carbon are the chief elements, which regulate the qualities of an iron and make it hard or soft, strong or weak. Silicon and sulphur are elements whose usefulness consists simply in their effect upon the carbon. I am not siding with the carbon faction in a discussion of the usefulness of these two elements, but I am trying to make prominent the fact that no element can be disregarded in the mixing of iron by chemical analysis. The chief trouble with the iron made during the rush period was that the irons were too low in carbon. An analysis for silicon would have been but little help to a founder whose iron had shrunk nor would an increase in the proportion of the silicon wholly avoid this difficulty.

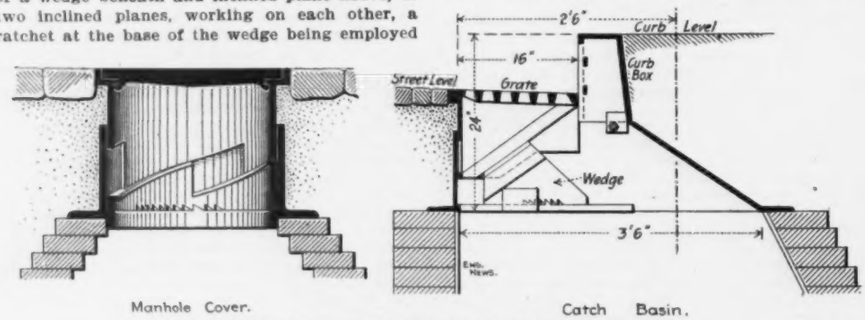
Foundries will profit then by the use of analysis, in proportion to the intelligence shown in its practice. The founder simply deludes himself when he considers that he is able to obtain the maximum benefits when using partial analyses. A benefit derived from mixing by silicon and sulphur is but an indication of the results that may be accomplished by making use of the full analysis.

ADJUSTABLE CATCHBASIN AND MANHOLE COVERS.

The accompanying illustrations show a form of adjustable coverings for catchbasins, manholes, hand and lampholes for sewerage and similar work.

It frequently happens that to give the proper crown to a street or depth to a gutter, the height of the curbstone above the pavement must vary at different points. In building manholes it is sometimes necessary to split the upper course of brick to adjust the cover to the street grade. In repaving streets or making other changes in the street surface level manhole covers and catchbasin inlet gratings sometimes have to be raised or lowered, or the latter may be required on account of wear in the pavement. Manhole covers, in particular, have a way of getting, or seeming to get, too high or too low in relation to the adjacent pavement, notably in macadam and dirt streets, and shortly after sewers are built and defective backfilling of trenches makes itself evident. Then, too, sewers and their various inlets are frequently built before the street surface is permanently improved.

The adjustable cover in question is simple in both design and operation. It is a combination of a wedge beneath and inclined plane above, or two inclined planes, working on each other, a ratchet at the base of the wedge being employed to prevent slipping. The accompanying illustrations show both a catchbasin and a manhole cover of this type.



ADJUSTABLE CATCHBASIN AND MANHOLE COVERS.
Made by the American Municipal Supply Co., Cleveland, O.

Referring to the section through the catchbasin cover, it may be seen that the grate support is separate from and works within the lower shell. The space being limited, the wedge here is moved only 3 ins., causing the grate and its support to rise or fall 3 ins. If still more variation is desired, use is made of the second inclined edge of the wedge, above and parallel with the first. Bringing this wedge into bearing raises the grate ½-in. more, and moving the wedge forward, as before, raises the grate another 3 ins., making 6½ ins. in all. Of course, the grate may be lowered by reversing the action just described. The adjustments may be made ½-in. at a time, thus giving 13 different positions. The portion of the cover built into the curb, as well as that fixed in the street, is not disturbed by the changes in level, all the adjustment being in the grate and its support. This presupposes a fixed curb, or curb line, both as to grade and alinement, the changes to be in the exposed portion of the curb, as altered by raising or lowering the street level at the gutter. No bolts or other fastenings are required, except a temporary bolt in assembling the parts.

The manholes are adjustable to 6 ins. The lower ring, shown in the illustration, is composed of four wedges. A strip or lug on the upper ring engages in a slot and prevents it from slipping.

These covers are made by the American Municipal Supply Co., Rose Building, Cleveland, O., to whom we are indebted for the material from which this article has been prepared.

THE SOULANGES CANAL WORKS, CANADA.*

By C. R. Coutlee,† Assoc. M. Can. Soc. C. E.

II.

CASCADES LOCKS.

The three Cascades locks, Fig. 13, are each 23½ ft. lift. With their attendant system of basins and reaches, they occupy about 4,000 ft. in length, the total descent made being 70½ ft. at low water. They are all in direct line, and between each the full prism of the canal, with 2 to 1 earth slope sides is resumed. The reach between the uppermost lock and the middle one is 1,600 ft. in length, and that between the middle and lower entrance lock is 1,000 ft. long. Alongside these locks and reaches, but sufficiently separated from them to prevent currents, are raceways and basins to feed the lower levels.

Each lockage requires about 303,000 cu. ft. of water, which, if drawn from the short canal reaches only, would lower them sufficiently to strand boats. To avoid this the surface is increased by side basins. The middle lock has a draft area of about 675,000 sq. ft., and the entrance lock has nearly 580,000 sq. ft., over which their respective "draw-offs" are distributed. As the full lift of the entrance lock (23½ ft.) is only attained at extremely low stages of the lake, its expenditure of water is generally less than the others. The side ponds are connected by regulating culverts, which can be made to operate automatically, and through these any loss in the lower reaches is quickly rectified.

Communication is secured throughout the system by three lines of roads, or tow-paths, 15 ft. wide each; one along the north of locks and reaches and one along the south of raceways and around the basins. A central path, with arch bridges, to allow of feed water communication, divides the reaches from the raceways. Over these paths carts can pass with machinery or supplies for repairs. The tow-paths are really only service roads, as all towing is done by tugs. Cast-iron mooring posts are provided along them at about 100-ft. intervals.

Splay walls below and above each lock secure the safe entry of boats. These are tangent to the lock wings and flare out at an angle of about 25° to the canal center line. Stone steps below each lock secure the rapid handling of hawsers from the lower to the upper level. In fact, easy access to all parts of the system is provided.

The topography is peculiarly well suited to this bold design of high lift locks. The first, or foot lock (Lock 1) is located just where the rock, Potsdam sandstone, reaches the greatest height in the Beauharnois anticlinal, and dips sharply into the Ottawa. To the west, the rock surface, though irregular, continues on a general level slightly above the canal bottom, as far as the second lock (Lock 2). Here it rises sufficiently to place this structure in from 2 to 12 ft. of rock cutting. The steep clay bluff, rising sharply from the rock at this point, serves to enclose the lock solidly in 50 ft. of impervious earth. Up to the next lock (Lock 3) the reach is a clay cut over 30 ft. in depth, the bottom being tough blue clay. Lock 3 was from 2 to 12 ft. above the rock surface, so pedestals of concrete were built and the lock walls founded upon them.

*The first article on the Soulanges Canal Works was published in Engineering News of April 18, 1901.
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LOCK CONSTRUCTION.

All three of the Cascades locks are founded upon rock. The pits were excavated and the loose stone piled at one side for use in making concrete. The irregularities of the bottoms of the pits were concreted up to floor level, and upon this the side walls were begun. Fig. 14 shows the general structural details of Lock No. 3, which will also serve to illustrate the similar construction of Locks Nos. 1 and 2.

The side walls of each lock are 355 ft. in length, 41½ ft. high, and 22 ft. wide at the base, finishing with a coping 5 ft. wide. Across the upper end a cross wall 23½ ft. high (the lift of the lock) acts as a revetment for the upper end of the pit. A breast wall, also 23½ ft. high, upon which are the miter sills for the upper gates, extends across about 50 ft. below the revetment wall, forming with it a head bay, from which the wall culverts are filled. All walls are built with plumb faces, and the backs are in steps. The full height of the face is of bush-hammered ashlar, which is backed with concrete. Vertical recesses, 4 ft. deep and 28½ ft. long, are made in the side walls to allow of the gates opening back flush with the general line of chamber wall. Each gate turns in a hollow quoin cut out of the stone; its heel rests upon a pivot casting, and it is held by a gudgeon and collar at the top. The gates miter against each other and close against sills of 18-in. × 18-in. oak, which are held down by bolts buried in a mass of concrete, as described for Lock No. 4.

The lower gates, Fig. 15, of these three locks are over 40 ft. high and 28 ft. wide, the clear width of the lock being 46 ft. The inclination of the miter sills in plan is 2 normal to and 1 along the center line of lock. The gates are of "built-up" construction, the bottom bars being 34 ins. through. The timber, Douglas fir, came from Vancouver. The larger gates weigh 70 tons.

Through each lock wall there is a longitudinal tunnel 6 ft. wide and 6 ft. high, with arched roof, having a total area of 67 sq. ft. These tunnels connect with the lock chamber through 20 openings, 10 each side, each 30 ins. in diameter, their combined area being about 98 sq. ft. The upper and lower ends of the tunnels are closed by "Stoney" sluices 6 ft. wide and 6 ft. high, which are operated by chains and counterweights through vertical wells in the masonry, 8 × 4 ft., extending from floor to coping. These valves, like the lock gates, have been subjected to 38½-ft. head, and are constantly operated under 23½-ft. head.

To fill the lock the lower valves are closed and the upper ones opened, which operation occupies about 1 min., the lock being full 3 mins. afterwards. The small locomotive tugs, which lose no time in entering the locks, are passed through in 7 mins. The filling by jets at the floor level produces no commotion, so vessels do not surge about. The valves being at floor level, are also easily got at for repairs, and the filling system requires no special foundations nor construction, but the longitudinal tunnels tend to widen the base of the walls without increasing the quantities.

Concrete is largely used here and elsewhere on the canal. Of 200,000 cu. yds of masonry, 150,000 cu. yds. are of this material. The essential part of concrete is cement, and this was all furnished by the Department of Railways & Canals, and not by the contractors. Thus the highest grade cements only have been used and in sufficient quantity. The half-dozen brands contracted for have invariably more than fulfilled the tests, which were continuously carried on at a laboratory upon the work.

The masonry work was carried on rapidly, 10,-

000 cu. yds. of concrete and face ashlar per month being laid during part of the year. No building was done at night; in fact, the night was needed to bring up supplies of cement, stone and sand for the next day's work. On the lock walls a course of ashlar was laid in full beds of 3 to 1 mortar, approaching ⅝-in. in thickness. The front of each vertical joint was plastered up for a couple of inches back before the adjoining stone was laid, and then the rest of the joint was dashed full of mortar from the rear. This gave strength enough to prevent the soft concrete backing, which was immediately laid, from bursting through the joints. After the concrete backing had set the whole course was grouted.

METHOD OF BUILDING.

Generally a four-mast traveling derrick, Fig. 16, mounted upon a strong trestle about half the height of the lock walls was used in constructing the lock. Beneath this were the supply tracks, one along each wall, and an outgoing empty track along the center. The two leading booms of the traveler laid the ashlar, and the two following booms lifted and deposited the concrete backing. Between times large masses of rough rock, from the excavation, were run in and let fall upon the viscous concrete.

Boxes, mounted on trolleys, were filled under a Cockburn concrete-mixer, which gave an almost continuous stream. An abundance of water was used in mixing and the walls were kept as wet as possible. The cubic-yard boxes were hoisted off their cars, swung over the wall and tripped about 3 ft. above; the box being allowed to drop upside down upon its contents. Very little leveling was required, but the concrete was well rammed back of the ashlar and along the back molds. These molds were of rough 1-in. boards assembled in panels and supported by posts and braces or anchored into the wall by telegraph wire. The panels were of the same height as the insteps along the back of the wall, and were used over and over again.

A four-mast traveler would lay 100 cu. yds. of ashlar and back it up with 300 cu. yds. of concrete and place in this 100 cu. yds. of displacers in a ten-hour day provided the material was supplied fast enough. Machine mixing of concrete was found to be quicker, better and more economical of cement. Carts or barrows dumped the stone in a ring around the hopper, then sand was spread over, and finally a barrel of cement for each cubic yard of broken stone. Twenty men were kept busy shoveling the dry materials over and over toward the hopper. The mixer did the rest, and the concrete dropped into boxes and was hauled by locomotives or horses to the lock. Gates crushers were used for breaking the concrete stone, and when possible the crushers and mixer were worked in battery side by side.

Large quantities of concrete were also mixed by hand. Sand was brought up in dump cars, partitioned off to give proper proportions, and the charge was spread upon a platform in a layer about 3 ins. thick. Over this a barrel of cement was spread, and the whole thoroughly mixed dry to an even purple color. Generally three barrels of sand to one barrel of cement were the proportions for the mortar. Water was added to make a liquid paste, and onto this 1 cu. yd. of broken stone, fine and coarse as it came from the crusher, but thoroughly wetted, was dumped and spread. It was then shoveled out into four heaps at the corners of the platform, then back to a heap in the middle, and lastly into cars, barrows or carts for conveyance to the walls. From 18 to 22 batches of about 1 cu. yd. each were mixed and loaded by five or six men in ten hours.

Generally, for both ashlar and concrete, including grouting and a mortar finish on exposed faces, the expenditure of cement was one barrel to a cubic yard. For concrete 1 barrel of cement = 3.2 cu. ft., and 3 barrels of sand = 9.6 cu. ft., and 8 barrels of broken stone = 25.2 cu. ft., were used. Great economy was effected by the use of displacers, often over a cubic yard in size, which saved cement to the Department and sand and broken stone to the contractor, and which hastened the work. Gravel would have further cheapened the concrete, but it was not used.

The ashlar is all bush-hammered limestone, and of large size, varying from 3 ft. to 1½ ft. in height and often 5 ft. deep and 8 ft. long. The contractors early appreciated that, as rough backs were allowed to project into the concrete backing, the larger the area the more profitable was the stone. Headers running 5 ft. back into the wall were required at 11-ft. intervals, and the bond was strictly not less than 12 ins. Stretchers were to be at least 2½ ft. deep into the wall, but generally they are nearly 4 ft. Hollow quoins are 6 × 6 ft., and recess quoins are of similar area of bed. Large block-stones, 5 × 5 ft. and 3 ft. thick, were placed under the gate pivots in a mass of concrete, and the miter sills are backed by blocks 3 ft. in thickness. Lock copings are uniformly 18 ins. thick, and 5 ft. wide on top, with a 1 to 1 frost batter. Some of these are upwards of 9 ft. in length.

The price per cubic yard bid for ashlar was from $14 to $16, and included all kinds of copes, quoins, arch stones, etc., only the net content of stones being paid for. Steps and large blocks were at special prices, of from $20 to $25 per cu. yd.

The general price for concrete, whether in backing of lock or in monolithic structures, was over $3, say $3.25 per cu. yd., and the barrel of cement cost on an average $2.50.

The derricks used upon the work had generally 70-ft. masts of Douglas fir and 60-ft. booms of the same timber. Six wire guys were used, and double blocks for the boom fall, and sometimes also for the main fall, rove with ⅝ to ½-in. steel wire. They were all furnished with a 12-ft. horizontal swinging circle and operated by one runner. The hoist boilers were about 25 HP., and the capacity of the derricks about 10 tons. To avoid hook holes, a face plate, lined with a 1-in. layer of lead, was used, and gave great satisfaction.

The locks are all founded upon rock, but at Lock No. 1 a transverse cravasse was encountered, which extended 12 ft. below the floor. From this 3,000 cu. yds. of wet clay gravel were excavated and replaced by concrete. The bottom of this crevice was 30 ft. below the water surface of the Ottawa, outside the entrance dam. In the pit for Lock No. 3, the rock dipped irregularly below the floor, so pedestals of concrete were made under each wall, 6,000 cu. yds. of concrete being used for the purpose. The pit was 50 ft. in depth, excavated largely in blue clay. A slip occurred at the head, where it was proposed to found a swing bridge. The material was partly excavated and then piles were driven. Between these the slipped material was replaced by loose stone, over which a 2-ft. platform of concrete was laid and the bridge built thereon.

REGULATING CULVERTS.

No overflow weirs are used, but regulating culverts, Fig. 15, the design of J. L. Allison, C. E., are used instead. There are two of these communicating between the side ponds and an outfall one. Each one consists of twin tunnels of concrete leading through the bottom of the embankment and throttled by "Stoney" sluices which operate upwards through shafts by the usual chains and counterweights.

The parallel tunnels are 6 ft. wide and 7 ft. high, with an arched roof 2 ft. thick, all formed as a concrete monolith. A smooth face finish was secured by the use of tarred paper spread over the molds, against which a 2-in. layer of mortar was plastered. This gave a smooth finish, but the imprisoned air left "worm marks." Stove-pipe iron gave a very smooth finish, and was much used by the writer in curved work.

For mortar facing a large "rake," or grating, 4 ft. long and 18 ins. high, formed of vertical iron rods, set 1 in. apart like teeth, in a flat bar, was used with economy and success. It was set against the face mold about 1½ ins. from it and held back the stone in the concrete mass till mortar was tamped in front and the grating withdrawn.

SPLAY WALLS.

Above and below each lock splay walls revet the sides until the 2 to 1 slope is reached by their spreading flare. These are very massive, and built as concrete monoliths, only the coping being of stone. Their section was determined by the Engineering News rule: "3-7 height and odd inches thrown in." The mean thickness thus obtained was multiplied by the height and this area distributed as the case allowed. All walls have plumb faces and their backs formed in steps, upon which, as far as possible, loose stone filling was piled. The base projected 1 ft. front and rear, which allowed of setting up mold posts and correcting alinement of face. The walls varied from 120 to 140 ft. in length, and were built without transverse bulkheads, but vertical slip joints were made where the wall joined the lock wing. These have proved quite sufficient for contraction, even though subjected to a range of from — 30° F. up to 120° F. Walls of immense size have developed hair cracks, but they are of no consequence, while the use of transverse bulkheads is a hindrance during construction, and a certain defect afterwards. Every structure stands upon its own bottom, however, slip joints having been formed at all junctions, and the results are most satisfactory after severe accidental tests.

Many "plums" were used in all the walls, some of "one-man" size stone, where the wall was narrow or derricks could not be had. Foundation concrete made of 1 to 5 mortar and 10 parts broken stone has given good results. No imitation of masonry coursing was permitted, but the layer marks were obliterated by a thorough coating of cement whitewash.

In the splay walls L-bolts are embedded by which horizontal 9 × 18-in. oak fenders are attached at about water level.

ARCH BRIDGES.

Along the south side of the reaches arch bridges are placed through which the side ponds connect with the canal proper (Fig. 14). These arch bridges are concrete monoliths in which a succession of arched openings 15 ft. span and 3.75 ft. rise are left. The bridges are all 10 ft. wide and have a stone coping on each side. A concrete platform 12 ft. wide and 2 ft. thick was first laid, and upon this the piers were built. Though many foundations are upon clay, timber grillages have not been used at all. Cracks in concrete slabs have been rare and of no consequence. In places where it was impracticable to keep structures flooded during winter the foundation slab with arches upon it was raised bodily 6 ins., but settled back to place again, and all the repairs necessary was to grout up the cracks.

MACHINERY.

At each lock there are four submerged "Stoney" sluices 6 × 6 ft. They are of the well-known "Stoney" type—a plate of steel fortified by I-beams and sliding upon nests of live rollers at each side. The valves are hung by chains passing over pocket wheels on a horizontal shaft with counterweights on the free ends (Fig. 14). The shafts can be evolved either by hand or by electric motors. These and the lock gates are arranged for operation from a switch-house situated at the middle of the lock on the north side.

The lock gates are closed and opened by a steel I-beam having a rack attached to one side, into which a pinion meshes. The point of attachment of the strut to the 42-ft. gates is 16 ft. from the bottom and 14 ft. from the heel. A chamber is provided in the lock walls into which the gate arm recedes.

For hanging the lock gates a pontoon (Fig. 18), 30 ft. square and drawing 10 ft., with a square tower about 30 ft. in height and the full size of the hull is used. A gate leaf is raised from a floating position to hang vertically against one side of the tower by wire cables passing over the top and wound around winches on each side. The gate is then floated into its recess, gently lowered onto its heel pivot and the top secured by a steel collar fitting over a gudgeon pin. R. & J. Miller were the contractors.

ELECTRICAL INSTALLATION.

As mentioned previously, the power-house is in combination with a waste weir about half-way down the summit level, the Grease River, which passes under the canal at this point being used as a tail race. A 20-ft. head is easily secured here and the area of the canal prism admits of a large discharge without creating an objectionable current, besides which, discharging into the stream creates no damage claims. Mr. A. M. Rice, of Dayton, O., designed the hydraulic development, and the Royal Electric Co., of Montreal, worked out

the electric power required and its application to locks, bridges and lighting. The contract for the work, however, was secured by the Canadian General Electric Co., who placed Mr. Hoffmeister in charge of the erection work.

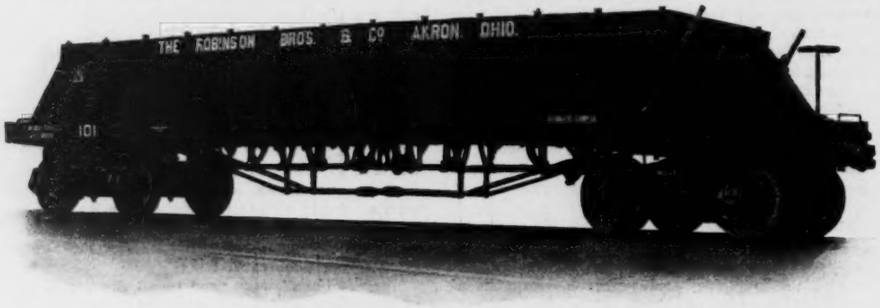

FIG. 1. WOODEN DUMP CAR FOR CARRYING SAND.
Ingoldsby Automatic Car Co., St. Louis, Mo.

POWER-HOUSE.—A gap in the south bank, about 120 ft. in length, is barred by a heavy concrete wall founded upon piles (Fig. 19). The middle third of this is widened out into the canal to form two vaults for wheel chambers. Three arched openings, closed by "Stoney" sluices, are placed on each side of the wheel pits to form regulating valves for the summit level. In each wheel chamber are four Victor wheels working on one horizontal shaft. Both shafts pass through the concrete dam in packing boxes to the generators. The dam forms one wall of the power-house, which is a handsome brick building with sandstone trimmings (Fig. 20).

There are two, 3-phase, 60-cycle generators of 264 K-W. each, direct-connected to the wheel shafts, which make 225 revolutions per minute, generating a pressure of 2,500 volts on the line. Two exciters of 15 K-W. each are belted direct to the wheel shafts. The switchboard is of marble; there are 2 generators, 2 feeders and 1 exciter panels fitted with the latest operating instruments.

DISTRIBUTION.—The pole line being on the opposite side of the canal, the current is carried across in four-lead armored cables to a switch cabin on the north bank, whence one power and light circuit is run up and one down the canal. The poles are of British Columbia red cedar, dressed octagonal and painted with four coats of white lead. They are spaced 120 ft. apart, every fourth pole carrying an enclosed arc lamp of 2,000 c. p. All poles are set 6 ft. into the ground, the line poles being 30 ft. and the lamp-posts 35 ft. in length.

On the upper circuit 6 wires of No. 6 B. & S. soft round copper are used, and on the lower 3 No. 4 wires and 3 No. 2. The line is protected by 91 Wurtz lightning arresters, placed wherever junctions are made with underground cables at locks or bridges. Six miles of armored cable are employed.

There are 220 long-burning, alternating-enclosed arc lamps of 2,000 c. p. each. Every light is equipped with a transformer of 1,000 Watts capacity. Besides the lights, placed at 480 ft. intervals along the canal bank, all the locks and entrance piers are lighted along both sides. Navigation is thus as easy by night as by day.

MOTORS.—At every lock four gate and four valve motors are provided, and one at each highway bridge. There is also a 15-HP. motor for the canal repair shops. The high-tension wires enter a switch cabin at each lock, where two transformers of 7,500 Watts capacity each reduce the pressure from 2,500 to 220 volts. This current is led direct to the gate and valve motors by underground cables controlled by the operating switchboard in each cabin. To facilitate the operation of the canal a bridging Bell telephone system connects all the locks, bridges and offices.

A NEW STYLE OF DUMP CAR.

The use of dump cars of high capacity for carrying, delivering and distributing coal, coke, ore, gravel, stone, ballast, etc., is extending very rapidly, and a number of different styles of such cars are in service, several of which have been described and illustrated in our columns. In most of these, the bottom is built either with a side slope or to form hoppers below the normal level of the floor, but the special feature of the Ingoldsby car, which is illustrated herewith, is that the bottom is flat. Fig. 1 is a general view of one of these cars built of wood, but they are built either of wood or steel to suit purchasers.

The ends of the car slope inward and downward, and the flat bottom is divided by a central ridge and a transverse member into four sections, each of which forms an opening about 12 ft. 6 ins. long and 2 ft. 10 ins. wide, the arrangement may be used for discharging the load into chutes or bins, filling trestles, widening embankments, or distributing earth or ballast in railway work. The doors can be held at any desired angle, so as to regulate the rate of discharge of the contents. They can also be operated simultaneously or separately, and by hand or air in the latter case they are controlled from the locomotive. Fig. 2 shows the positions of the doors when closed, center dumping and side dumping. Fig. 3 shows an elevation and plans. The advantages claimed are in greater capacity and greater facility of dumping, as compared with other cars.

The sides form plate girders, and the main portion of the underframing consists of a pair of Pratt trusses forming the center sills. The sides have inclined stiffeners, and inclined braces are fitted at the ends. The cars are about 41 ft. 9 ins. long over the sills, 9 ft. 3 ins. wide inside, and 8 ft. deep inside, the top being 8 ft. 4 ins. above the rail. For carrying coal and coke, portable wooden tops can be attached, as shown in Fig. 2, increasing the depth about 16 ins. The cars are built either of wood or steel, with rated capacities of 50,000, 80,000 and 100,000 lbs., but the actual loads are said to be higher. The largest cars, built of steel, weigh about 38,200 lbs., and will carry 110,000 lbs. This gives a live or paying load of 65.3% of the total weight of the loaded car. With the top boards in place and the load crowned 30°, the load may be increased to 113,000 lbs., or 2,175 cu. ft.

The doors are held in the closed position by locking bars, placed vertically, and connected to rods operated by hand levers at the ends of the car. After being opened, they are raised by chains wound on central shafts, each operated by a crank handle and bevel gear at the end of the car. They may also be operated by air, as already noted.

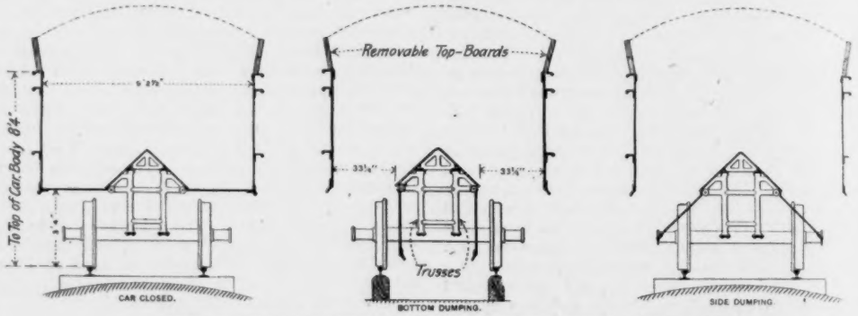

FIG. 2. CROSS-SECTIONS OF INGOLDSBY STEEL DUMP CAR.

The cars are the invention of Mr. F. S. Ingoldsby, Vice-President and General Manager of the Ingoldsby Automatic Car Co., Chemical Building, St. Louis, Mo. A number of the cars, both of wood and steel construction, are now in use, for hauling and delivering ore and other material, and for hauling and distributing ballast, etc., in railway work. The advantages claimed are in the greater cubic capacity and the greater facility for dumping rapidly, as compared with other cars. The flat bottom also renders the car

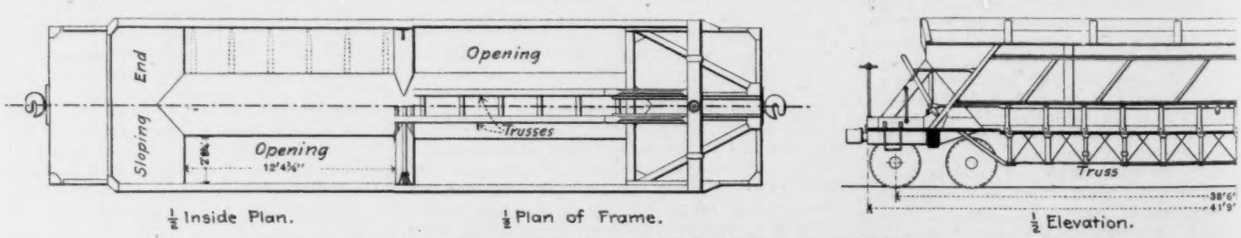

FIG. 3. PLAN AND ELEVATION OF INGOLDSBY STEEL DUMP CARS.

equipped with a transformer of 1,000 Watts capacity. Besides the lights, placed at 480 ft. intervals along the canal bank, all the locks and entrance piers are lighted along both sides. Navigation is thus as easy by night as by day.

MOTORS.—At every lock four gate and four valve motors are provided, and one at each highway bridge. There is also a 15-HP. motor for the

tual dimensions varying in different cars. The four doors which form the bottom of the car are so hung that the load can be dropped either vertically or at one or both sides of the track. The former method is most commonly used in unloading at coal and ore trestles, and sometimes for filling railway trestles, etc. This gives a clear opening of about 137 sq. ft. The side dumping

available for general freight purposes, so that it can be loaded for the return trip instead of being hauled empty. The inventor suggests the construction of box cars of this type for hauling grain, which can be dumped directly into the boots of the elevators in much less time than the grain can be discharged from ordinary box cars, even by the use of mechanical shovels.

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